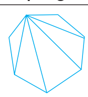
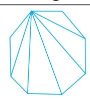
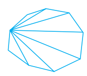
Answers

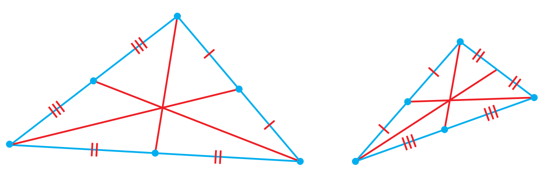
Chapter 1

Lesson 1.1, page 12

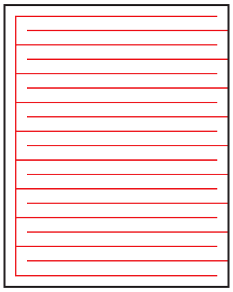
1. e.g., The manager made the conjecture that each type of ski would sell equally as well as the others.
2. Tomas's conjecture is not reasonable. $99(11) = 1089$
3. e.g., The sum of two even integers is always even. For example, $6 + 12 = 18 \quad 34 + 72 = 106$
4. e.g., The yellow symbolizes the wheat fields of Saskatchewan, the green symbolizes the northern forests, and the fleur de lys represents la Francophonie.
5. e.g., Mary made the conjecture that the sum of the angles in quadrilaterals is 360°.
6. e.g., The fewest number of triangles in a polygon is the number of sides subtracted by 2.

Polygon	heptagon	octagon	nonagon
Fewest Number of Triangles	 5	 6	 7

7. e.g., The result is always an even number ending with a decimal of .25.
8. **a)** e.g., The sums of the digits of multiples of 3 are always 3, 6, or 9.
9. e.g., The sum of one odd integer and one even integer is always odd.
   $3 + 4 = 7$
   $-11 + 44 = 33$
   $90 + 121 = 211$
10. e.g., The temperature on November 1 in Hay River never goes above 5 °C. My conjecture is supported by the data: none of the temperatures are above 5 °C.
11. e.g., Paula's conjecture is reasonable. When you multiply an odd digit with an odd digit, the result is odd:
    $1(1) = 1; 3(3) = 9; 5(5) = 25; 7(7) = 49; 9(9) = 81$
    Since the ones of a product are the result of a multiplication of two digits, squaring an odd integer will always result in an odd integer.
12. e.g., The diagonals of rectangles intersect each other at their midpoints. I used my ruler to check various rectangles.
13. e.g., Text messages are written using small keypads or keyboards, making text entry difficult. Abbreviations reduce the difficult typing that needs to be done, e.g., LOL is 3 characters, "laugh out loud" is 14.
14. e.g., Nick made the conjecture that the medians of a triangle always intersect at one point.



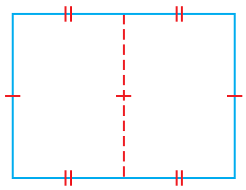
15. e.g., If March comes in like a lamb, it will go out like a lion. People may have noticed that when the weather was mild at the beginning of March, or near the end of winter, there would be bad weather at the end of March, or near the beginning of spring.
16. e.g., The town will be in the bottom right of the map near the mouth of the large river. People tend to live near bodies of fresh water, and this is one of the few flat areas on the map.
17. e.g., If social networking sites were the only way to pass information among people, it is reasonable that everyone would access such a site once per day to connect with people or obtain news. Because of various schedules (e.g., working or sleeping during the day, time zones), it is reasonable that it would take at least 12 h for the news to reach the whole Canadian population.
18. e.g., Thérèse's conjecture is possible. Cut the paper along the red lines. Unfold to form a hole larger than the original piece of paper.



19. e.g., A conjecture is a belief, and inferences and hypotheses are also beliefs. However, conjectures, inferences, and hypotheses are validated differently because they relate to different subjects: mathematics/logic, literature, and science.
20. e.g., The photograph is of a shadow of a statue holding a globe.
    The photograph is of a shadow of a soccer goalie, near the goal, holding the ball above her head.
    The picture is of a shadow of a child holding a ball above his head near a swing set.
21. e.g., The statement is not a conjecture. The company making the claim probably surveyed some dentists to get their opinion; however, these dentists' opinion may not represent that of all dentists.
22. e.g., Conjectures about sports may not be accurate because a player or a team's performance may change depending on the health of the player or the constitution of the team.

Lesson 1.2, page 17

1. e.g., The dimensions of the tabletops are the same. A ruler may be used to measure them.
2. e.g., The pattern will continue until 12345678987654321; after that, it will change. I can test my conjecture using a spreadsheet.
3. e.g., When two congruent polygons are positioned so that there is a common side, the polygon formed will have $2n - 2$ sides, where n is the number of sides in one original polygon. My conjecture is invalid. The resulting figure is 4-sided:



Lesson 1.3, page 22

1. e.g.,
   a) 0 is a number that is not negative, and is not positive.
   b) 2 is a prime number that is not odd.
   c) Muggsy Bogues was an NBA player who was 1.6 m (5 ft 3 in.) tall.

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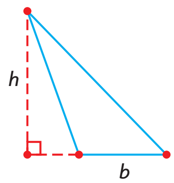
d) The height of a triangle can lie outside the triangle.



e) If a city's shape is roughly rectangular and it lies along a northeast-southwest axis, then the map will be set to accommodate the city's shape, and the north arrow would instead point toward a corner of the map.

f) $\sqrt{0.01} = 0.1$

g) $-10 + 5 = -5$

h) Travelling north in the southern hemisphere generally results in a warmer climate.

2. Disagree. e.g., The sides of a rhombus are equal, but its angles may not be 90°.

3. Disagree. e.g., $1(10) = 10$

4. Disagree. e.g., $9 + 12 = 21$

5. Disagree. e.g., 99. $9 + 9 = 18$. $18 \neq 9$

6. Disagree. e.g., a kite with angles of 90°, 45°, 90°, and 135°

7. e.g., Claire's conjecture seems reasonable because so many combinations are possible. I tried a few examples.

Number	Expression
6	$\frac{6}{\sqrt{4}}(7 - 5)$
10	$\frac{6(5)}{7 - 4}$
19	$4(5) - 7 + 6$

8. e.g., My evidence strengthens George's conjecture. For example,
$123456789 \cdot 4 + 9 = 493827165$
$1234567891011 \cdot 4 + 11 = 4938271564055$

9. e.g., The sum of digits in any multiple of 9 greater than zero will be divisible by 9.

10. e.g., Patrice's conjecture is reasonable. Integers separated by a value of 2 will both be odd or both be even, and their squares will both be odd or both be even. Adding two even numbers together and adding two odd numbers together result in an even number.

11. e.g., Geoff's conjecture is not valid. Kites and rhombuses have perpendicular diagonals.

12. e.g., Amy's conjecture could be changed to "When any number greater than 1 is multiplied by itself, it will be greater than the starting number."

13. e.g., Any real number is divisible by another real number.
$\frac{425.353}{1.35} = 315.076\ldots$ $\frac{\pi}{\sqrt[3]{9}} = 1.510\ldots$
Counterexample: 0 is a real number for which division is not defined.

14. Disagree. e.g., The number 2 cannot be written as the sum of consecutive numbers.

15. e.g., Blake's claim is not valid. The number 3 cannot be written as the sum of three primes.

16. e.g.,

a) $18 = 5 + 13$
$54 = 11 + 43$
$106 = 5 + 101$

b) A counterexample would be an even number that is not equal to the sum of two primes.

17. e.g.,

a) The number picked and the final result are the same.

b) I cannot find a counterexample. This does not imply that the conjecture is valid, but it does strengthen it.

18. e.g., Inductive reasoning can be used to make a conjecture; a conjecture is supported by evidence and can be invalidated by a counterexample.

19. Disagree. e.g., $4^2 - 3 = 13$

20. **a)** e.g.,

0%	There won't be rain, even if it's cloudy. Perfect for a day at the lake.
10%	Little chance of rain or snow. A good day for a hike.
20%	No rain is expected; good weather for soccer.
30%	There's a small chance of rain. I'll risk a game of ultimate at the local park.
40%	It might rain, but I might skateboard close to home.
50%	It's a good idea to bring an umbrella or rain jacket on the way to school.
60%	It's a very good idea to bring an umbrella or rain jacket on the way to school.
70%	The chance for no rain is 3 out of 10—I'll stay inside and watch a movie.
80%	Rain is likely. I'll read a book.
90%	It will almost certainly rain. I'll spend time surfing the Internet.
100%	It will definitely rain. I'll play a game of basketball indoors.

b) e.g., For probabilities of 30% or less, I'd definitely go outside because of the low chance of rain. For probabilities of 40%–50%, I would still go outdoors because it's about a 1 in 2 chance it will rain. For 60% or more, which is closer to a two-thirds chance that it will rain, I would definitely stay indoors.

21. Agree. e.g., If n is odd, its square will be odd. Two odd numbers and one even number added together result in an even number. If n is even, then three even numbers are added together, and that results in an even number.

Lesson 1.4, page 31

1. e.g., Let n be any number.
$(n - 3) + (n - 2) + (n - 1) + n + (n + 1)$
$+ (n + 2) + (n + 3) = 7n$
Since n is the median, Chuck's conjecture is true.

2. Austin got a good haircut.

3. e.g., The angles formed at the intersection of the diagonals are two pairs of opposite, equal angles.

4. e.g., Let $2n$ and $2m$ represent any two even numbers.
$2n + 2m = 2(n + m)$
Since 2 is a factor of the sum, the sum is even.

5. Let $2n + 1$ represent an odd number and $2m$ represent an even number.
$2m(2n + 1) = 4mn + 2m$
$2m(2n + 1) = 2(2mn + m)$
Since 2 is a factor of the product, the product is even.

6. e.g., Using the Pythagorean theorem, we can show that the first and third triangles have a right angle opposite the hypotenuse.
$4^2 + 3^2 = 16 + 9$ $\quad$ $6^2 + 8^2 = 36 + 64$
$4^2 + 3^2 = 25$ $\quad$ $6^2 + 8^2 = 100$
$4^2 + 3^2 = 5^2$ $\quad$ $6^2 + 8^2 = 10^2$
Angle b and the right angle are supplementary. Angle b is 90°.

7. **a)** e.g.,

n	5	0	-11
$\times 4$	20	0	-44
$+10$	30	10	-34
$\div 2$	15	5	-17
-5	10	0	-22
$\div 2$	5	0	-11
$+3$	8	3	-8

b)

n	n
$\times 4$	$4n$
$+10$	$4n + 10$
$\div 2$	$2n + 5$
-5	$2n$
$\div 2$	n
$+3$	$n + 3$

8. e.g., The premise that khaki pants are comfortable does not exclude other pants from being comfortable.

9. e.g.,

n	n
$\times 2$	$2n$
$+6$	$2n + 6$
$\times 2$	$4n + 12$
-4	$4n + 8$
$\div 4$	$n + 2$
-2	n

10. e.g., Let $2n + 1$ represent any odd integer.
$(2n + 1)^2 = 4n^2 + 2n + 2n + 1$
The numbers $4n^2$ and $2n$ are even. The addition of 1 makes the result odd.

11. e.g.,
$4^2 - 6^2 = 16 - 36$ $\quad$ $5^2 - 7^2 = 25 - 49$
$4^2 - 6^2 = -20$ $\quad$ $5^2 - 7^2 = -24$
Let n represent any number.
$n^2 - (n - 2)^2 = n^2 - (n^2 - 4n + 4)$
$n^2 - (n - 2)^2 = n^2 - n^2 + 4n - 4$
$n^2 - (n - 2)^2 = 4n - 4$
$n^2 - (n - 2)^2 = 4(n - 1)$
The difference is a multiple of 4.

12. e.g.,

Choose a number.	n
Add 5.	$n + 5$
Multiply by 3.	$3n + 15$
Add 3.	$3n + 18$
Divide by 3.	$n + 6$
Subtract the number you started with.	6

13. e.g., Let $abcd$ represent any four-digit number.
$abcd = 1000a + 100b + 10c + d$
$abcd = 2(500a + 50b + 5c) + d$
The number $abcd$ is divisible by 2 only when d is divisible by 2.

14. e.g., Let ab represent any two-digit number.
$ab = 10a + b$
$ab = 5(2a) + b$
The number ab is divisible by 5 only when b is divisible by 5.
Let abc represent any three-digit number.
$abc = 100a + 10b + c$
$abc = 5(20a + 2b) + c$
The number abc is divisible by 5 only when c is divisible by 5.

15. e.g., Let ab represent any two-digit number.
$ab = 10a + b$
$ab = 9a + (a + b)$
The number ab is divisible by 9 only when $(a + b)$ is divisible by 9.
Let abc represent any three-digit number.
$abc = 100a + 10b + c$
$abc = 99a + 9b + (a + b + c)$
The number abc is divisible by 9 only when $(a + b + c)$ is divisible by 9.

16. e.g.,
$\frac{5^2}{4} = 6.25$ $\quad$ $\frac{11^2}{4} = 30.25$ $\quad$ $\frac{23^2}{4} = 132.25$
When an odd number is squared and divided by four, it will always result in a decimal number ending with 0.25.
Let $2n + 1$ represent any odd number.

$$\frac{(2n + 1)^2}{4} = \frac{4n^2 + 4n + 1}{4}$$
$$\frac{(2n + 1)^2}{4} = \frac{4(n^2 + n) + 1}{4}$$
$$\frac{(2n + 1)^2}{4} = (n^2 + n) + \frac{1}{4}$$
$$\frac{(2n + 1)^2}{4} = (n^2 + n) + 0.25$$

An odd number squared, then divided by four, will always result in a decimal number ending with 0.25.

17. e.g., Joan and Garnet used inductive reasoning to provide more evidence for the conjecture, but their solutions aren't mathematical proofs. Jamie used deductive reasoning to develop a generalization that proves Simon's conjecture.

18. e.g., Let x represent the original number; let d represent the difference between x and its nearest lower multiple of 10.
Step 1: $x - d$
Step 2: $x + d$
Step 3: $(x + d)(x - d) = x^2 - d^2$
Step 4: $x^2 - d^2 + d^2 = x^2$

19. e.g., $n^2 + n + 2 = n(n + 1) + 2$
The expression $n(n + 1)$ represents the product of an odd integer and an even integer. The product of an odd integer and an even integer is always even (see question 5). Adding 2 to an even number results in an even number.

20. e.g., Conjecture: The product of two consecutive natural numbers is always even.
The product of two consecutive natural numbers is the product of an odd integer and an even integer.

Answers

Let $2n$ and $2n + 1$ represent any two consecutive natural numbers when the even number is less than the odd number.
$2n(2n + 1) = 4n^2 + 2n$
$2n(2n + 1) = 2(2n^2 + n)$
Let $2n$ and $2n - 1$ represent any two consecutive natural numbers when the odd number is less than the even number.
$2n(2n - 1) = 4n^2 - 2n$
$2n(2n - 1) = 2(2n^2 - n)$
In both cases, the product has a factor of 2. The product of two consecutive natural numbers is always even.

Mid-Chapter Review, page 35

1. e.g., The medicine wheel's spokes may have pointed toward celestial bodies at solstices and equinoxes.

2. e.g., The squares follow a pattern of $t + 1$ fours, t eights, and 1 nine, where t is the term number. For example, the second term, $t = 2$, is $667^2 = 444889$
The 25th term in the pattern will be 25 sixes and 1 seven, squared, and the result will be 26 fours, 25 eights, and 1 nine.

3. e.g.,
a) The sum of the numbers in the 10th row will be 512.
b) The sum of any row is $2^{(r-1)}$, where r is the row number.

4. e.g., Glenda's conjecture seems reasonable. For the countries whose names begin with A, B, C, or S, there are 30 countries whose names end with a consonant and 42 whose names end with a vowel.

5. e.g., Igor Larionov is a Russian hockey player who was inducted into the Hockey Hall of Fame in 2008.

6. Disagree. e.g., The diagonals of parallelograms and rhombuses also bisect each other.

7. Disagree. e.g., For example, the conjecture "all prime numbers are odd" can be supported by 10 examples (3, 5, 7, 9, 11, 13, 17, 19, 23, 29), but the conjecture is not valid: 2 is an even prime number.

8. e.g.,
a) If 5 is chosen, the result is 5. If 2 is chosen, the result is 5.
Conjecture: The number trick always has a result of 5.

n	n
$+ 3$	$n + 3$
$\times 2$	$2n + 6$
$+ 4$	$2n + 10$
$\div 2$	$n + 5$
$- n$	5

b) If 7 is chosen, the result is 7. If 4 is chosen, the result is 7.
Conjecture: The number trick always has a result of 7.

n	n
$\times 2$	$2n$
$+ 9$	$2n + 9$
$+ n$	$3n + 9$
$\div 3$	$n + 3$
$+ 4$	$n + 7$
$- n$	7

9. e.g.,
Let n, $n + 1$, $n + 2$, and $n + 3$ represent any four consecutive natural numbers.
$n + (n + 1) + (n + 2) + (n + 3) = 4n + 6$
$n + (n + 1) + (n + 2) + (n + 3) = 2(2n + 3)$
Since 2 is a factor of the sum, the sum of four consecutive natural numbers is always even.

10. e.g.,

$(7 + 11)^2 = 324$	$(1 + 10)^2 = 121$	$(3 + 5)^2 = 64$
$7^2 + 11^2 = 170$	$1^2 + 10^2 = 101$	$3^2 + 5^2 = 34$
$(7 + 11)^2 > 7^2 + 11^2$	$(1 + 10)^2 > 1^2 + 10^2$	$(3 + 5)^2 > 3^2 + 5^2$

Let n and m be any two positive integers.
The square of the sum of two positive integers:
$(n + m)^2 = n^2 + 2mn + m^2$
The sum of the squares of two positive integers:
$n^2 + m^2$
Since $2mn > 0$ for all positive integers,
$n^2 + 2mn + m^2 > n^2 + m^2$
The square of the sum of two positive integers is greater than the sum of the squares of the same two integers.

11. e.g.,
Let $2n + 1$ represent any odd integer.
$(2n + 1)^2 - (2n + 1) = (4n^2 + 4n + 1) - (2n + 1)$
$(2n + 1)^2 - (2n + 1) = 4n^2 + 2n$
$(2n + 1)^2 - (2n + 1) = 2(2n^2 + n)$
Since the difference has a factor of 2, the difference between the square of an odd integer and the integer itself is always even.

Lesson 1.5, page 42

1. e.g.,
a) The statement "all runners train on a daily basis" is invalid.
b) The reasoning leading to the conclusion is invalid. Rectangles also have four right angles.

2. e.g., The first line of the proof is invalid.

3. e.g., In line 5, Mickey divides by $(a - b)$, which is invalid because $a - b = 0$.

4. e.g., Noreen's proof is not valid. Neither figure is a triangle, as in each case what appears to be the hypotenuse is actually two segments not along the same line (determine the slope of the hypotenuse of each small triangle to verify). When no pieces overlap, the total area is the sum of the areas of the individual pieces. That total area is 32 square units.

5. Ali did not correctly divide by 2 in line 4.

6. e.g., With a street address of 630 and an age of 16:

630	630
$\times 2$	1 260
$+ 7$	1 267
$\times 50$	63 350
$+ 16$	63 366
$- 365$	63 001
$+ 15$	63 016

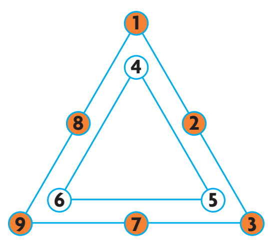
b) Connie subtracted the wrong number for days of the year. There are 365 days in the year. Her final expression should be $100n + 350 + a - 365 + 15 = 100n + a$
c) The number of the street address is multiplied by 100, making the tens and ones columns 0. The age can be added in without any values being carried.

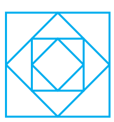
7. e.g., In line 7, there is a division by 0. Since $a = b$, $a^2 - ab = 0$.

8. e.g., False proofs appear true because each mathematical step involved in the reasoning seems sound. In a false proof, there is one (or more) incorrect steps that are misinterpreted as being correct.
9. e.g., In general, strips of paper have two sides, a back and a front. A mark made on the front will not continue to the back unless the paper is turned over. When joined as described in the question, the piece of paper has only one side and is called a Mobius strip. A single, continuous mark can be made along the paper without turning it over.
10. e.g., The question is misleading. Each person initially paid \$10 for the meal, but got \$1 back. So, each person paid \$9 for the meal. The meal cost \$25. The waiter kept \$2.
$3(9) - 2 = 25$

Lesson 1.6, page 48

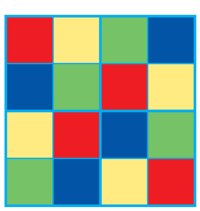
1. **a)** inductive **b)** deductive **c)** inductive **d)** deductive **e)** inductive
2. e.g., Many solutions are possible. The middle triangle must add up to 15 (e.g., 1, 5, 9; 3, 4, 8) and the outer triangle must add up to 30 (e.g., 2, 3, 4, 6, 7, 8; 1, 2, 5, 6, 7, 9).



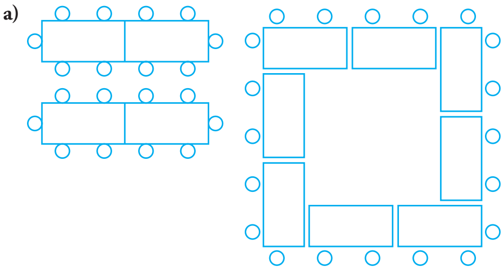
3. 

4. **a)** e.g.,

1	2	3
333	666	999
333	666	999
333	666	999
+333	+666	+999
1333	2666	3999

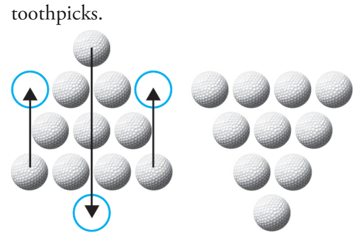
b) three
5. e.g.,
a) 

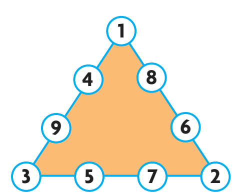
b) Different approaches to the problem could include deductive reasoning or trial and error.
6. e.g., Let A represent one side of the river and B the other. Move goat to B; return to A. Move wolf to B; return with goat to A. Move hay to B; return. Move goat to B.
7. 28

8. The brother is a liar.
9. Bob is the quarterback, Kurt is the receiver, and Morty is the kicker.
10. e.g.,
a) The pair 2, 6 cannot be in envelope 8 because the 6 is required for envelope 13 or 14.
b) deductive
11. $abcd = 2178$
12. e.g.,
a) 

b) The solution is simple and allows for everyone to be heard.
13. Tamara
14. 35
15. **a)** Suganthy
b) deductive
16. Pour water from the second pail into the fifth one.
17. e.g., A problem can be solved using inductive reasoning if it has a pattern that can be continued. A problem can be solved using deductive reasoning if general rules can be applied to obtain the solution. It is not always possible to tell which kind of reasoning is needed to solve a problem.
18. 10 days
19. Arlene
20. Pick a fruit from the apples and oranges box. Because the label is incorrect, the fruit picked determines which label goes on this box: apple or orange. Say an orange was picked. Since the labels are incorrect on the two remaining boxes, the box with the apples label is the apples and oranges box, and the box that had the oranges label on it is the apple box.

Lesson 1.7, page 55

1. 120; the pattern is $n(n + 2)$
2. e.g., triple 20, double 3; double 20, double 10, double 3; triple 10, triple 10, double 3
3. e.g., To win, you must leave your opponent with 20, 16, 12, 8, and 4 toothpicks.
4. 

5. **a)** e.g.,


b) e.g., I determined the possible combinations for 9, 8, and 7. I identified common addends and put those in the triangle's corners and completed the sides.

Answers

6. e.g.,

a) Numbers in each column go up by 3. Numbers in each row go up by 4.

b)

6	10	14
9	13	17
12	16	20

Selva's observation that the magic sum is three times the number in the middle square holds. My magic sum is 39.

c) The numbers in any square follow the pattern below.

$n - 7$	$n - 3$	$n + 1$
$n - 4$	n	$n + 4$
$n - 1$	$n + 3$	$n + 7$

If $n - 7$ is chosen, n and $n + 7$ may be chosen, or $n + 3$ and $n + 4$ may be chosen. All possible choices are listed below.

$(n - 7) + n + (n + 7) = 3n$
$(n - 7) + (n + 3) + (n + 4) = 3n$
$(n - 4) + (n - 3) + (n + 7) = 3n$
$(n - 4) + (n + 3) + (n + 1) = 3n$
$(n - 1) + (n - 3) + (n + 4) = 3n$
$(n - 1) + n + (n + 1) = 3n$

All choices result in the magic sum, which is three times the number in the middle square.

7. e.g.,

a) 3 (or 24 for all permutations)

b) The number in the middle is always odd.

c) Show that the number in the middle must be odd and that there are four solutions for each odd number in the middle.

8. e.g., Put the two coins on the same diagonal.

9. Player O started the game.

10. a)

5	1	3	2	6	4
2	6	4	5	1	3
1	5	2	3	4	6
3	4	6	1	5	2
6	3	5	4	2	1
4	2	1	6	3	5

b)

6	3	4	8	2	5	7	9	1
9	5	8	3	7	1	4	6	2
2	7	1	4	6	9	3	5	8
1	4	5	6	8	3	2	7	9
3	6	7	9	1	2	8	4	5
8	9	2	7	5	4	6	1	3
7	1	3	2	9	6	5	8	4
4	8	9	5	3	7	1	2	6
5	2	6	1	4	8	9	3	7

11. a)

2	7	6
9	5	1
4	3	8

b)

2	9	4
7	5	3
6	1	8

12. 20

13.

30 × **6**	**5**	36 × **3**	2 ÷ **2**	**1**	18 + **4**
3 + **1**	**2**	**6**	7 + **4**	**3**	**5**
2	20 × **4**	**5**	5 − **1**	**6**	**3**
1 − **5**	2 − **3**	**1**	**6**	13 + **4**	**2**
4	7 + **1**	**2**	2 − **3**	**5**	**6**
2 ÷ **3**	**6**	**4**	3 − **5**	**2**	**1**

14. e.g., Using inductive reasoning, I can observe a pattern and use it to determine a solution. Using deductive reasoning, I can apply logical rules to help me solve a puzzle or determine a winning strategy for a game.

15. e.g.,

a) I would play in a spot with the fewest possibilities for placing three of my markers in a row.

b) Inductive reasoning helps me guess where my opponent will play; deductive reasoning helps me determine where I should play.

Chapter Self-Test, page 58

1. e.g.,

a) Figure 4 would have one additional cube at the end of each arm, requiring 16 cubes in all. Figure 5 would have 5 cubes more than Figure 4, with one at the end of each arm, requiring 21 cubes in all.

b) The nth structure would require $5n - 4$ cubes to build it.

c) 121 cubes

2. His conjecture isn't reasonable: the chance of the coin coming up heads is 50%.
3. e.g., A pentagon with sides of length 2 has a perimeter of 10.
4. Let $2n + 1$ and $2n + 3$ represent two consecutive odd integers. Let P represent the product of these integers.
$P = (2n + 1)(2n + 3)$
$P = 4n^2 + 8n + 3$
$P = 2(2n^2 + 4n) + 3$
$2(2n^2 + 4n)$ is an even integer, 3 is an odd integer, and the sum of any even and odd integer is an odd integer, so the product of any two consecutive odd integers is an odd integer.
5. e.g.,

n	n
$\times 2$	$2n$
$+ 20$	$2n + 20$
$\div 2$	$n + 10$
$- n$	10

6. Darlene, Andy, Candice, Bonnie
7. The proof is valid; all the steps are correct.

Chapter Review, page 61

1. e.g., The diagonals of parallelograms always bisect each other. The diagrams in the question support my conjecture.
2. e.g.,
   a) The difference between consecutive triangular numbers increases by 1: 2, 3, 4, … The next four triangular numbers are 15, 21, 28, and 36.
   b) Each of the products is double the first, second, third, and fourth triangular numbers, respectively.
   c) The nth triangular number could be determined using the formula $\frac{n(n + 1)}{2}$.
3. e.g.,
   a) The sum of the cubes of the first n natural numbers is equal to the square of the nth triangular number.
   b) The next equation will be equal to 15^2, or 225.
   c) The sum of the first n cubes will be equal to $\left(\frac{n(n + 1)}{2}\right)^2$.
4. e.g.,
   a) $37 \times 15 = 555$
   b) The conjecture is correct.
   c) The breakdown occurs at $37 \times 30 = 1110$.
5. e.g.,
   a) A counterexample is an example that invalidates a conjecture.
   b) Counterexamples can help refine a conjecture to make it valid.
6. Disagree. e.g., Rhombuses and parallelograms have opposite sides of equal length.
7. Disagree. e.g., $5 - 7 = -2$
8. Six is an even number; therefore, its square is also even.
9. e.g.,
Let $2m + 1$ and $2n + 1$ represent any two odd integers.
$(2m + 1)(2n + 1) = 2mn + 2m + 2n + 1$
$(2m + 1)(2n + 1) = 2(mn + m + n) + 1$
The first term has a factor of 2, making it an even number. Adding 1 makes the product odd.
10. a) The result is the birth month number followed by the birthday, e.g., 415.
   b)

m	m
$\times 5$	$5m$
$+ 7$	$5m + 7$
$\times 4$	$20m + 28$
$+ 13$	$20m + 41$
$\times 5$	$100m + 205$
$+ d$	$100m + 205 + d$
$- 205$	$100m + d$

The birth month is multiplied by 100, leaving enough space for a two-digit birthday.
11. a) e.g., Twice the sum of the squares of two numbers is equal to the sum of the squared difference of the numbers and the squared sum of the numbers.
   b) Let n and m represent any two numbers.
$2(n^2 + m^2) = 2n^2 + 2m^2$
$2(n^2 + m^2) = n^2 + n^2 + m^2 + m^2 + 2mn - 2mn$
$2(n^2 + m^2) = (n^2 - 2mn + m^2) + (n^2 + 2mn + m^2)$
$2(n^2 + m^2) = (n - m)^2 + (n + m)^2$
$2(n^2 + m^2) = a^2 + b^2$
Let a represent $n - m$ and b represent $n + m$.
A sum of two squares, doubled, is equal to the sum of two squares.
12. e.g., On the fourth line there is a division by zero, since $a = b$.
13. Julie did not multiply 10 by 5 in the third line.

n	Choose a number.
$n + 10$	Add 10.
$5n + 50$	Multiply the total by 5.
$5n$	Subtract 50.
5	Divide by the number you started with.

14. One of the women is both a mother and a daughter.
15.

Penny Pig	straw	small	Riverview
Peter Pig	sticks	large	Hillsdale
Patricia Pig	brick	medium	Pleasantville

16. Player X should choose the bottom left corner, then the top left corner, then the middle left or middle, depending on where Player X was blocked.
17. e.g.,
   a) yes
   b) There is no winning strategy in the game of fifeen. An experienced opponent will always succeed in blocking you.

Chapter 2

Lesson 2.1, page 72

1. e.g.,

a) Horizontal beams are parallel.
Vertical supports are parallel.
Diagonal struts are transversals.

b) No. The bridge is shown in perspective. Parallel lines on the bridge will not be parallel when they are traced, so corresponding angles will not be equal in the tracing.

2. $\angle EGB = \angle GHD$, $\angle AGE = \angle CHG$, $\angle AGH = \angle CHF$, $\angle BGH = \angle DHF$, $\angle EGA = \angle HGB$, $\angle EGB = \angle HGA$, $\angle GHD = \angle FHC$, $\angle GHC = \angle FHD$, $\angle EGA = \angle FHD$, $\angle EGB = \angle FHC$, $\angle GHD = \angle HGA$, $\angle GHC = \angle BGH$
Yes, the measures are supplementary.

3. e.g., Draw a line and a transversal, then measure one of the angles between them. Use a protractor to create an equal corresponding angle elsewhere on the same side of the transversal. Use that angle to draw the parallel line.

4. e.g., The top edge of the wood is the transversal for the lines that are drawn. Keeping the angle of the T-bevel the same makes parallel lines because corresponding angles are equal.

5. **a)** No. Corresponding angles are not equal.
b) Yes. Corresponding angles are equal.
c) Yes. Corresponding angles are equal.
d) No. Corresponding angles are not equal.

6. Disagree. The lines are equidistant from each other. It is an optical illusion.

Lesson 2.2, page 78

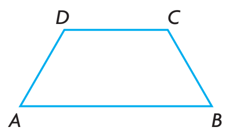
1. KP, LQ, MR, and NS are all transversals for the parallel lines WX and YZ.
$\angle WYD = 90°$; $\angle WYD$ and $\angle AWY$ are interior angles on the same side of KP.
$\angle YDA = 115°$; $\angle YDA$ and $\angle WAL$ are corresponding angles.
$\angle DEB = 80°$; $\angle DEB$ and $\angle EBC$ are alternate interior angles.
$\angle EFS = 45°$; $\angle EFS$ and $\angle NCX$ are alternate exterior angles.

2. **a)** Yes. Corresponding angles are equal.
b) No. Interior angles on the same side of the transversal are not supplementary.
c) Yes. Alternate exterior angles are equal.
d) Yes. Alternate exterior angles are equal.

3. e.g.,
a) Alternate interior angles are equal.
b) Corresponding angles are equal.
c) Alternate exterior angles are equal.
d) Opposite angles are equal.
e) $\angle b$ and $\angle k$ and $\angle m$ are all equal in measure; $\angle b$ and $\angle k$ are corresponding angles, $\angle k$ and $\angle m$ are corresponding angles.
f) $\angle e$ and $\angle n$ and $\angle p$ are all equal in measure; $\angle e$ and $\angle n$ are corresponding angles, $\angle n$ and $\angle p$ are corresponding angles.
g) $\angle n$ and $\angle p$ and $\angle d$ are all equal in measure; $\angle n$ and $\angle p$ are corresponding angles, $\angle p$ and $\angle d$ are alternate exterior angles.
h) $\angle f$ and $\angle k$ are interior angles on the same side of a transversal.

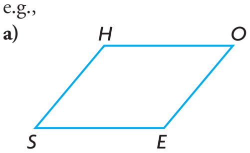
4. **a)** $\angle x = 60°$, $\angle y = 60°$, $\angle w = 120°$
b) $\angle a = 112°$, $\angle e = 112°$, $\angle b = 55°$, $\angle d = 55°$, $\angle f = 55°$, $\angle c = 68°$
c) $\angle a = 48°$, $\angle b = 48°$, $\angle c = 48°$, $\angle d = 48°$, $\angle e = 132°$, $\angle f = 132°$, $\angle g = 132°$

5. e.g.,



I drew AB and used a protractor to create a 60° angle at A and at B. I used a ruler to make sure AD and BC were both 2 cm long. Then I connected D and C.

6. e.g.,
a)



b) $\angle S = 50°$
$\angle H + \angle S = 180°$
$\angle H = 130°$
$\angle H + \angle O = 180°$
$\angle O = 50°$
$\angle S = \angle O$

7. **a)** e.g., The horizontal lines in the fabric are parallel and the diagonal lines are transversals. The diagonal lines falling to the right are parallel and the diagonal lines rising to the right are transversals.
b) e.g., A pattern maker could ensure that lines in the pattern are parallel by making the corresponding, alternate exterior, or alternate interior angles equal, or by making the angles on the same side of a transversal supplementary.

8. **a)** The transitive property is true for parallel lines but not for perpendicular lines.
b) If $AB \perp BC$ and $BC \perp CD$, then $AB \parallel CD$.

9. e.g., Theoretically, they could measure corresponding angles to see if they were equal.

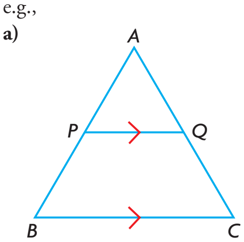
10. e.g., errors: interior angles should be stated as supplementary, not equal. Since $\angle PQR + \angle QRS = 180°$, the statement that $QP \parallel RS$ is still valid.

11. e.g., The bottom edges of the windows are transversals for the vertical edges of the windows. The sloped roof also forms transversals for the vertical parts of the windows. The builders could ensure one window is vertical and then make all the corresponding angles equal so the rest of the windows are parallel.

12. e.g.,

$SR \parallel XO$	$\angle FOX$ and $\angle FRS$ are equal corresponding angles
$PQ \parallel XO$	$\angle FPQ$ and $\angle FXO$ are equal corresponding angles.
$PQ \parallel SR$	Transitive property

13. e.g.,
a)



b)

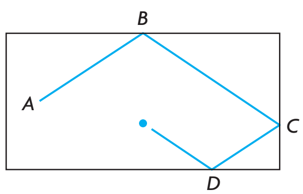
$\angle APQ = \angle ABC$	Corresponding angles
$\angle AQP = \angle ACB$	Corresponding angles
$\angle PAQ = \angle BAC$	Same angle
$\triangle APQ \sim \triangle ABC$	Corresponding angles in the two triangles are equal.

14. **a)** $\angle x = 120°, \angle y = 60°, \angle z = 60°$
b) e.g., Isosceles trapezoids have two pairs of congruent adjacent angles.

15. $\angle PTQ = 78°, \angle PQT = 48°, \angle RQT = 49°, \angle QTR = 102°, \angle SRT = 54°, \angle PTS = 102°$

16. $\angle ACD = \angle ACF + \angle FCD$
$\angle BAC = \angle ACF$
$\angle CDE = \angle FCD$
$\angle ACD = \angle BAC + \angle CDE$

17. **a)** Alternate straight paths will be parallel.
b)



c) $AB \parallel CD, BC \parallel DE$
d) Yes, the pattern will continue until the ball comes to rest.

18. e.g.,

$\angle PQR = \angle QRS$	Alternate angles
$\frac{1}{2}\angle PQR = \frac{1}{2}\angle QRS$	Equality
$\angle TRQ = \frac{1}{2}\angle PQR$	Angle bisector
$\angle RQU = \frac{1}{2}\angle QRS$	Angle bisector
$\angle TRQ = \angle RQU$	Transitive property
$QU \parallel RT$	Alternate angles are equal.

19. e.g.,
a) Disagree; it is enough to show that any one of the statements is true.
b) Yes. Other ways are
$\angle MCD = \angle CDQ, \angle XCL = \angle CDQ, \angle LCD + \angle CDQ = 180°, \angle LCD = \angle QDY, \angle MCD = \angle RDY, \angle XCM = \angle QDY$, or $\angle XCL = \angle RDY$.

20. **a)** 8 **b)** 7

21. e.g.,
a) Measure the top angle of the rhombus at the left end of the bottom row; it will be the same size as the angle at the peak.
b) Opposite sides of a rhombus are parallel, so the top right sides of all the rhombuses form parallel lines. The top right side of the peak rhombus and the top right side of the bottom left rhombus are parallel. The left edge of the pyramid is a transversal, so the angle at the peak and the top angle of the bottom left rhombus are equal corresponding angles.

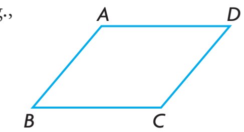
Mid-Chapter Review, page 85

1. **a)** Yes. Alternate interior angles are equal.
b) No. Interior angles on the same side of the transversal are not supplementary.
c) Yes. Opposite angles and corresponding angles are equal.
d) Yes. Opposite angles are equal and interior angles on the same side of the transversal are supplementary.

2. Quadrilateral *PQRS* is a parallelogram because interior angles on the same side of the transversal are supplementary.

3. e.g., The red lines are parallel since the vertical distance between the red lines is always the same.

4. e.g.,



I drew $\angle ABC$. I measured it and drew $\angle BCD$ supplementary to it. Then I measured *AB*, made *CD* the same length, and connected *A* to *D*.

5. **a)** $\angle FEB = 69°, \angle EBD = 69°, \angle FBE = 36°, \angle ABF = 75°, \angle CBD = 75°, \angle BDE = 75°$
b) Yes. e.g., $\angle FEB$ and $\angle EBD$ are equal alternate interior angles.

6. e.g.,
a)

$AC \parallel ED$	$\angle ABE$ and $\angle BED$ are equal alternate interior angles.

b)

$\angle BED = 55°$ and $\angle BFG = \angle BED$, therefore $\angle BFG = 55°$	$\angle BFG$ and $\angle BED$ are corresponding angles in $\triangle BFG \sim \triangle BED$.
$FG \parallel ED$	$\angle BFG$ and $\angle BED$ are equal corresponding angles for *FG* and *ED*.

c)

$AC \parallel FG$	$\angle ABF$ and $\angle BFG$ are equal alternate interior angles.

7. e.g., In each row of parking spots, the lines separating each spot are parallel. The line down the centre is the transversal to the two sets of parallel lines.

8. e.g., Yes, the sides are parallel. The interior angles are supplementary and so the lines are always the same distance apart.

Lesson 2.3, page 90

1. No. It only proves the sum is 180° in that one triangle.

2. Disagree. The sum of the three interior angles in a triangle is 180°.

3. **a)** $\angle YXZ = 79°, \angle Z = 37°$
b) $\angle DCE = 46°, \angle A = 85°$

4. $\angle R = \frac{1}{2}(180° - n°)$

5. e.g.,

$\angle CDB = 60°$	$\triangle BCD$ is equilateral.
$\angle CDB + \angle BDA = 180°$ $\angle BDA = 120°$	$\angle CDB$ and $\angle BDA$ are supplementary.
$\angle A = \frac{1}{2}(180° - 120°)$ $\angle A = 30°$	Since $\triangle BDA$ is an isosceles triangle, $\angle A$ and $\angle B$ are equal.

6. 120°

7. e.g.,

$\angle ASY = 53°$	Sum of angles in triangle is 180°.
$\angle SAD = 127°$	Given
$\angle ASY + \angle SAD = 180°$	Property of equality
$SY \parallel AD$	Interior angles on the same side of the transversal are supplementary.

8. e.g.,

a) The sum of $\angle a$, $\angle c$, and $\angle e$ is 360°.

b) Yes. $\angle b = \angle a$, $\angle d = \angle c$, $\angle f = \angle e$

c)

$\angle x + \angle a = 180°$ $\angle a = 180° - \angle x$	$\angle x$ and $\angle a$ are supplementary.
$\angle y + \angle c = 180°$ $\angle c = 180° - \angle y$	$\angle y$ and $\angle c$ are supplementary.
$\angle z + \angle e = 180°$ $\angle e = 180° - \angle z$	$\angle z$ and $\angle e$ are supplementary.
$\angle a + \angle c + \angle e$ $= (180° - \angle x) +$ $(180° - \angle y) + (180° - \angle z)$ $= 540° - (\angle x + \angle y + \angle z)$	I substituted the expressions for $\angle a$, $\angle c$, and $\angle e$.
$= 540° - 180°$ $= 360°$	$\angle x$, $\angle y$, and $\angle z$ are the angles of a triangle so their sum is 180°.

9. e.g.,

a) $\angle D \neq \angle C$

b)

$\angle DKU = \angle KUC$ $\angle DKU = 35°$	$\angle DKU$ and $\angle KUC$ are alternate interior angles.
$\angle DUK = 180° - (100° + 35°)$ $\angle DUK = 45°$	The sum of the angles of $\triangle DUK$ is 180°.
$\angle UKC = 45°$	$\angle DUK$ and $\angle UKC$ are alternate interior angles.
$\angle UCK = 100°$	Opposite angles in a parallelogram are equal.

10. e.g.,

$MA \parallel HT$	$\angle MTH$ and $\angle AMT$ are equal alternate interior angles.
$MH \parallel AT$	$\angle MHT = 70°$ and $\angle HTA = 45° + 65°$ are supplementary interior angles on the same side of transversal HT.

11. $\angle a = 30°$, $\angle b = 150°$, $\angle c = 85°$, $\angle d = 65°$

12. e.g.,

a) Disagree. $\angle FGH$ and $\angle IHJ$ are not corresponding angles, alternate interior angles, or alternate exterior angles.

b)

$\angle GFH = 180° - (55° + 75°)$ $\angle GFH = 50°$	The sum of the angles of $\triangle FGH$ is 180°.
$FG \parallel HI$	$\angle GFH$ and $\angle IHJ$ are equal corresponding angles.

13. $\angle J = 110°$, $\angle M = 110°$, $\angle JKO = 40°$, $\angle NOK = 40°$, $\angle KLN = 40°$, $\angle LMN = 40°$, $\angle MLN = 30°$, $\angle JOK = 30°$, $\angle LNO = 140°$, $\angle KLM = 70°$, $\angle JON = 70°$

14. $\angle UNF = 31°$, $\angle NFU = 65°$, $\angle FUN = 84°$

15. **a)** $\angle AXZ = 145°$, $\angle XYC = 85°$, $\angle EZY = 130°$

b) 360°

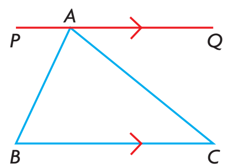
16. e.g.,

MO and ON are angle bisectors.	Given
$\angle LNP$ is an exterior angle for $\triangle LMN$.	
$\angle L + 2a = 2b$ $\angle L = 2b - 2a$ $\angle L = 2(b - a)$	An exterior angle is equal to the sum of the non-adjacent interior angles.
$\angle ONP$ is an exterior angle for $\triangle MNO$.	
$\angle O + a = b$ $\angle O = b - a$	An exterior angle is equal to the sum of the non-adjacent interior angles.
$\angle L = 2(b - a)$ $\angle O = b - a$ $\angle L = 2\angle O$	Substitution

17. e.g., Drawing a parallel line through one of the vertices and parallel to one of the sides creates three angles whose sum is 180°. The two outside angles are equal to the alternate angles in the triangle. The middle angle is the third angle in the triangle. Therefore, the three angles in the triangle add up to 180°.

$\angle PAB = \angle ABC$

$\angle QAC = \angle ACB$

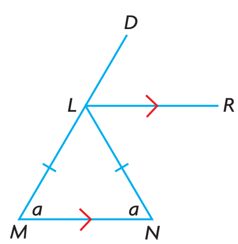


18. e.g.,

$\angle DAB + \angle ABD + \angle BDA = 180°$	The sum of the angles of $\triangle ABD$ is 180°.
$2\angle x + (90° + \angle y) + \angle y = 180°$ $2\angle x + 2\angle y = 90°$ $\angle x + \angle y = 45°$	
$\angle AEB = \angle x + \angle y$	$\angle AEB$ is an exterior angle for $\triangle AED$, so it is equal to the sum of the non-adjacent interior angles.
$\angle AEB = 45°$	Substitute $\angle x + \angle y = 45°$.

19. e.g.,

$\angle DLR = \angle LMN$	Corresponding angles
$\angle RLN = \angle LNM$	Alternate angles
$\angle LMN = \angle LNM$	Isosceles triangle
$\angle DLR = \angle RLN$	Transitive property



Lesson 2.4, page 99

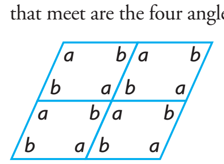
1. **a)** 1800° **b)** 150°

2. 3240°

3. 19

4. e.g., The interior angles of a hexagon equal 120°. Three hexagons will fit together since the sum is 360°.

5. Yes. e.g., You can align parallel sides to create a tiling pattern; the angles that meet are the four angles of the parallelogram, so their sum is 360°.



6. about 147°

7. e.g.,

a) $$\frac{180°(n-2)}{n} = 140°$$
$$180°(n-2) = 140°n$$
$$180°n - 360° = 140°n$$
$$40°n = 360°$$
$$n = 9$$

b) There are 9 exterior angles that measure $180° - 140° = 40°$; $9(40°) = 360°$.

8. **a)** 45° **c)** 1080°
b) 135° **d)** 1080°

9. **a)** Agree
b) e.g., Opposite sides are parallel in a regular polygon that has an even number of sides.

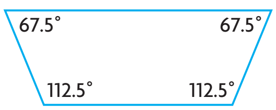
10. **a)** 36° **b)** isosceles triangle

11. The numerator of the formula for $S(10)$ should be $180°(10-2)$; $S(10) = 144°$.

12. **a)** e.g., A single line drawn anywhere through the polygon. For convex polygons, it intersects two sides only. For non-convex polygons, it can intersect in more than two sides.
b) If any diagonal is exterior to the polygon, the polygon is non-convex.

13. **a)**

b)



14. 100°, 120°, 90°, 110°, 110°

15. 360°

16. **a)** $\angle a = 60°$, $\angle b = 60°$, $\angle d = 60°$, $\angle c = 120°$
b) $\angle a = 140°$, $\angle b = 20°$, $\angle c = 60°$, $\angle d = 60°$

17. 720°

18. e.g.,

$\triangle EOD \cong \triangle DOC$	$EO = DO$ and $DO = CO$ are given, and $ED = DC$ because the polygon is regular.
$\angle ODE = \angle ODC$ and $\angle ODE = \angle OED$	$\triangle EOD$ and $\triangle DOC$ are congruent and isosceles.
$\angle ODE + \angle ODC = 108°$	The interior angles of a regular pentagon are 108°.
$2\angle ODE = 108°$ $\angle ODE = 54°$	$\angle ODE = \angle ODC$
$\angle EAD = \angle EDA$	$\triangle ADE$ is isosceles because the polygon is regular.
$180° = \angle DEA + \angle EAD + \angle ADE$ $180° = 108° + 2\angle ADE$ $2\angle ADE = 180° - 108°$ $\angle ADE = 36°$	
$180° = \angle FED + \angle EDF + \angle EFD$ $180° = 54° + 36° + \angle EFD$ $\angle EFD = 180° - 54° - 36°$ $\angle EFD = 90°$	$\angle EDF = \angle ADE$ and $\angle FED = \angle OED$

19. e.g., If a polygon is divided into triangles by joining one vertex to each of the other vertices, there is always two fewer triangles than the original number of sides. Every triangle has an angle sum of 180°.

20. Yes, e.g., A tiling pattern can be created by putting four 90° angles together or three 120° angles together.

21. regular dodecagon

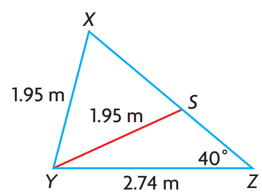
Lesson 2.5, page 106

1. **a)** *SSS*
b) *ASA*, because you can determine the third angle.
c) *SAS*
d) *SSS*, because they are right triangles, you can use Pythagorean theorem to find the third side.

2. **a)** Yes, because you can determine the measure of the third angle, so the triangles are congruent by *ASA*.
b) No, because you don't know the length of any sides. These triangles will be similar, but there is no guarantee that they are congruent.

3. **a)** $AB = XY$; $\angle A = \angle X$; $AC = XZ$, so $\triangle ABC \cong \triangle XYZ$ by *SAS*
b) $FH = JK$; $\angle H = \angle K$; $HG = KL$, so $\triangle FHG \cong \triangle JKL$ by *SAS*
c) $CA = BU$; $AR = US$; $CR = BS$, so $\triangle CAR \cong \triangle BUS$ by *SSS*
d) $\angle O = \angle A$; $OG = AT$; $\angle G = \angle T$, so $\triangle DOG \cong \triangle CAT$ by *ASA*

4. Yes, e.g., If $XY < YZ$, then it is possible that two different triangles can be drawn. For example, in the diagram, two triangles are shown given that information: $\triangle XYZ$ and $\triangle SYZ$.



Lesson 2.6, page 112

1. **a)** $\triangle SLY \cong \triangle FOX$ (*ASA*)
b) Triangles cannot be proven congruent (*SSA* is not a congruence theorem).
c) $\triangle PET \cong \triangle DOG$ (*SAS*)
d) $\triangle RED \cong \triangle SUN$ (*SSS*)

2. **a)** $\angle CDB = \angle ABD$ (alternate interior angles); $DB = BD$ (common); $\angle CBD = \angle ADB$ (alternate interior angles); $\triangle CDB \cong \triangle ABD$ by *ASA*
b) $\angle POY = \angle NOY$ (given); $OY = OY$ (common); $\angle PYA = \angle NYA$, so $\angle PYO = \angle NYO$ (supplements of equal angles are also equal); $\triangle POY \cong \triangle NOY$ by *ASA*
c) $JL = NL$ (given); $\angle JLK = \angle NLM$ (vertically opposite angles); $KL = ML$ (given); $\triangle JLK \cong \triangle NLM$ by *SAS*

3. **a)** e.g., Yes, they appear to have the same size and shape.
b) e.g., Measure the length of the base of the triangle. Measure the angles next to the base, *ASA*.

4. e.g.,

$\angle T = \angle C$	Given
$TI = CA$	Given
$\angle I = \angle A$	Given
$\triangle TIN \cong \triangle CAN$	*ASA*
$IN = AN$	If two triangles are congruent, their corresponding parts are equal.

5. e.g.,

$TQ = PQ$	Given
$\angle TQR = \angle PQS$	Vertically opposite angles
$RQ = SQ$	Given
$\triangle TQR \cong \triangle PQS$	*SAS*
$TR = PS$	If two triangles are congruent, their corresponding parts are equal.

6. e.g.,

WY bisects $\angle XWZ$ and $\angle XYZ$	Given
$\angle XWY = \angle ZWY$	Each angle is $\frac{1}{2}$ of $\angle XWZ$.
$WY = WY$	Common side
$\angle XYW = \angle ZYW$	Each angle is $\frac{1}{2}$ of $\angle XYZ$.
$\triangle XWY \cong \triangle ZWY$	*ASA*
$XY = ZY$	If two triangles are congruent, their corresponding parts are equal.

7. e.g.,

$\angle PRQ = \angle PSQ$	Given
$\triangle PRS$ is isosceles.	Base angles are equal.
$PR = PS$	Two sides of an isosceles triangle are equal.
Q is the midpoint of RS.	Given
$RQ = SQ$	Midpoint cuts RS in half.
$QP = QP$	Common side
$\triangle PRQ \cong \triangle PSQ$	*SSS*
$\angle PQR = \angle PQS$	If two triangles are congruent, their corresponding parts are equal.
$\angle PQR + \angle PQS = 180°$	They form a straight line.
$\angle PQR = 90°$ and $\angle PQS = 90°$	Two angles that are equal and have a sum of 180° must each be 90°.
$PQ \perp RS$	PQ and RS form 90° angles.

8. e.g.,

a)

$QP \perp PR$; $SR \perp RP$	Given
$\triangle QPR$ and $\triangle SRP$ are right triangles.	$QP \perp PR$; $SR \perp RP$
$PR = PR$	Common side
$QR = SP$	Given
In $\triangle QPR$: $QP^2 = QR^2 - PR^2$	Pythagorean theorem
In $\triangle SRP$: $SR^2 = SP^2 - PR^2$	Pythagorean theorem
$SR^2 = QR^2 - PR^2$	Substitution; $QR = SP$
$\therefore SR^2 = QP^2$ and $SR = QP$	Transitive property
$\therefore \triangle QPR \cong \triangle SRP$	*SSS*
$\angle PQR = \angle RSP$	If two triangles are congruent, then their corresponding angles are equal.

b)

$QP \perp PR$; $SR \perp RP$	Given
$\triangle QPR$ and $\triangle SRP$ are right triangles.	$QP \perp PR$; $SR \perp RP$
$PR = PR$	Common side
In $\triangle QPR$: $\sin \angle PQR = \frac{PR}{QR}$ In $\triangle SRP$: $\sin \angle RSP = \frac{PR}{PS}$ $QR = SP$	Given
$\frac{PR}{QR} = \frac{PR}{PS}$	$PR = PR$ and $QR = SP$, so the ratios are equal.
$\therefore \sin \angle PQR = \sin \angle RSP$	Transitive property
$\angle PQR$ and $\angle RSP$ are both acute angles.	Each angle is in a right triangle.
$\angle PQR = \angle RSP$	If the sines of two acute angles are equal, the angles must be equal.

9. e.g.,

$\angle ABC = \angle DEC$	Given
$\angle ACB = \angle DCE$	Vertically opposite angles
$\angle ABC + \angle ACB + \angle BAC = \angle DEC + \angle DCE + \angle CDE$	Sum of angles of a triangle is 180°.
$\angle BAC = \angle CDE$	Since two pairs of angles of two triangles are equal, the third pair of angles must also be equal.
$AB = DE$	Given
$\triangle ABC \cong \triangle DCE$	*ASA*
$BC = EC$	If triangles are congruent, then their corresponding sides are equal.
$\triangle BCE$ is isosceles.	Two sides of the triangle are equal.

10. e.g.,

MT is the diameter of the circle.	Given
$\angle MAT = 90°$ and $\angle MHT = 90°$	An angle inscribed in a semicircle is 90°.
$TA = TH$	Given
$MT = MT$	Common side
$AM = HM$	If two sides of two right triangles are equal, by using Pythagorean theorem, the third sides will be equal.
$\triangle MAT \cong \triangle MHT$	*SSS*
$\therefore \angle AMT = \angle HMT$	If two triangles are congruent, their corresponding angles are equal.

11. Duncan's proof contains two errors: $\angle ABF$ and $\angle DCE$ are not alternate interior angles. Also, he used AE and DF as sides of the two triangles. The sides are AF and DE.

Corrected Proof:

$AB \parallel CD$	Given
$\angle BAF = \angle CDE$	Alternate interior angles
$BF \parallel CE$	Given
$\angle BFA = \angle CED$	Alternate interior angles
$AE = DF$	Given
$EF = EF$	Common side
$\therefore AF = DE$	Segment addition
$\triangle BAF \cong \triangle CDE$	*ASA*

12. e.g.,

In $\triangle ACD$, $\angle ACD = \angle ADC$	Given
$\triangle ACD$ is isosceles.	Base angles are equal.
$AC = AD$	Two sides of isosceles triangle are equal.
$\angle ACB + \angle ACD = 180°$; $\angle ADE + \angle ADC = 180°$	The angles form a straight line.
$\angle ACB + \angle ACD = \angle ADE + \angle ADC$	Transitive property
$\angle ACB = \angle ADE$	Subtraction
$CB = DE$	Given
$\triangle ABC \cong \triangle AED$	*SAS*

13. e.g.,

$TA = EM$	Given
$\angle MEA = \angle TAE$	Given
$AE = EA$	Common side
$\triangle TEA \cong \triangle MAE$	*SAS*
$\angle TEA = \angle MAE$	Corresponding angles in congruent triangles are equal.
$\angle TEA - \angle MEA = \angle MAE - \angle TAE$	Subtraction
$\angle TEM = \angle MAT$	Substitution

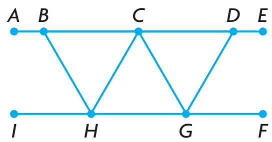
14. e.g.,

$GH \perp HL$; $ML \perp HL$	Given
$\angle GHK = 90°$ and $\angle MLJ = 90°$	Perpendicular lines meet at right angles.
$HJ = LK$	Given
$JK = KJ$	Common side
$HJ + JK = LK + KJ$	Addition
$HK = LJ$	Substitution
$GH = ML$	Given
$\triangle GHK \cong \triangle MLK$	*SAS*
$\angle NKJ = \angle NJK$	Corresponding angles in congruent triangles are equal.
$\triangle NJK$ is isosceles.	Base angles are equal.

15. e.g.,

$\triangle PQT$ is isosceles.	Given
$PQ = PT$	An isosceles triangle has two equal sides.
$\angle PQT = \angle PTQ$	Base angles of isosceles triangle are equal.
$QS = TR$	Given
$\triangle PQS = \triangle PTR$	*SAS*
$\angle PSR = \angle PRS$	Corresponding angles in congruent triangles are equal.
$\triangle PRS$ is isosceles.	Base angles are equal.

16. e.g., Draw a diagram of a section of the crane's arm.



$AE \parallel IF$	Given
BH, HC, CG, and GD are all the same length.	Given
$\triangle HBC$, $\triangle CHG$ and $\triangle GCD$ are isosceles.	Two sides are equal in each triangle.
$\angle CBH = \angle BCH$ $\angle CHG = \angle CGH$ $\angle DCG = \angle CDG$	Base angles in an isosceles triangle are equal.
$\angle BCH = \angle CHG$ $\angle CGH = \angle DCG$	Alternate interior angles
$\angle CBH = \angle CHG$ $\angle BCH = \angle CGH$ $\angle CDG = \angle CGH$ $\angle DCG = \angle CHG$	Transitive property
$\angle BHC = \angle HCG$ $\angle HCG = \angle CGD$ $\angle BHC = \angle CGD$	If two sets of angles in two triangles are equal, the third set is equal.
$\therefore \triangle HBC \cong \triangle CHG$, $\triangle HBC \cong \triangle GCD$, $\triangle CHG \cong \triangle GCD$	*ASA*
Since the crane is built so that all diagonal truss supports are equal, the rest of the triangles can be proven congruent in the same way.	

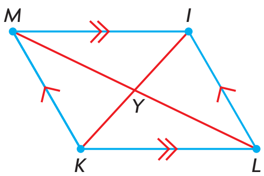
17. e.g.,

$QA = QB$	Given
$\angle Q = \angle Q$	Common side
$AR = BS$	Given
$QA + AR = QB + BS$	Addition
$QR = QS$	Substitution
$\triangle RQB \cong \triangle SQA$	*SAS*
$RB = SA$	Corresponding sides of congruent triangles are equal.

18. Answers will vary.

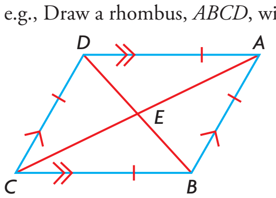
Answers

19. e.g., Draw a parallelogram, *MILK*, with diagonals intersecting at *Y*.



MI ∥ *LK*; *MK* ∥ *IL*	*MILK* is a parallelogram.
∠*MIK* = ∠*LKI* ∠*LIK* = ∠*MKI*	Alternate interior angles
IK = *KI*	Common side
△*MIK* ≅ △*LKI*	*ASA*
MI = *LK*	Corresponding sides of congruent triangles are equal.
∠*IML* = ∠*KLM*	Alternate interior angles
△*MIY* ≅ △*LKY*	*ASA*
MY = *LY*; *IY* = *KY*	Corresponding sides of congruent triangles are equal.
∴ Diagonals *ML* and *IK* bisect each other at *Y*.	*MY* = *LY*; *IY* = *KY*

20. e.g., Draw a rhombus, *ABCD*, with diagonals intersecting at *E*.



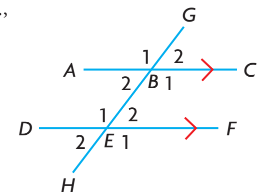
ABCD is a rhombus.	Given
DA ∥ *BC*; *CD* ∥ *BA*	Opposite sides of a rhombus are parallel.
AB = *BC* = *CD* = *DA*	All sides of a rhombus are equal.
∠*ADE* = ∠*CBE*; ∠*DAE* = ∠*BCE*	Alternate interior angles
△*DAE* ≅ △*BCE*	*ASA*
DE = *BE*; *CE* = *AE*	Corresponding parts of congruent triangles are equal.
∴ *DB* and *CA* bisect each other at *E*.	Definition of bisect
△*DAE* ≅ △*BCE* ≅ △*BAE* ≅ △*DCE*	*SSS*
∴ ∠*AED* = ∠*CEB* = ∠*AEB* = ∠*CED*	Corresponding parts of congruent triangles are equal.
∠*AED* + ∠*CEB* + ∠*AEB* + ∠*CED* = 360°	They form 2 pairs of supplementary angles.
∴ ∠*AED* = ∠*CEB* = ∠*AEB* = ∠*CED* = 90°	Algebra
∴ diagonals *DB* and *CA* are perpendicular to each other.	Definition of perpendicular

Chapter Self-Test, page 116

1. **a)** $\angle a = 70°$, $\angle b = 75°$, $\angle c = 75°$
b) $\angle a = 20°$, $\angle b = 80°$, $\angle c = 100°$

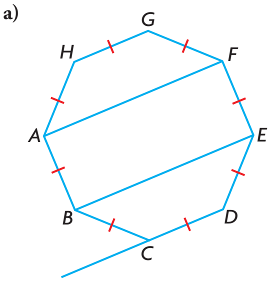
2. **a)** $x = 19°$ **b)** $x = 26°$

3. **a)** and **c)** e.g.,



4. regular hexagons: six 120° angles; small triangles: three 60° angles; large triangles: one 120° angle and two 30° angles.

5. **a)**



b) 45°

c) e.g.,

∠*AHG* = 135° and ∠*FGH* = 135°	Regular octagon
∠*HAF* = 45° and ∠*GFA* = 45°	Exterior angle of regular octagon
∠*HAB* = ∠135°	Regular octagon
∠*HAB* = ∠*HAF* + ∠*FAB* 135° = 45° + ∠*FAB*	Addition and substitution
∠*FAB* = 90°	Solve for ∠ *FAB*
Similarly, ∠*ABE* = 90°	Symmetry
AF ∥ *BE*	Supplementary angles

6. e.g.,

OY = *OZ*	Radii of circle, centred at *O*
YX = *ZX*	Given
OX = *OX*	Common side
△*OXY* ≅ △*OXZ*	*SSS*
∠*OXY* = ∠*OXZ*	Corresponding angles of congruent triangles are equal.

7. e.g.,

LM = *NO*	Given
∠*LMO* = ∠*NOM*	Given
MO = *OM*	Common side
△*LMO* ≅ △*NOM*	*SAS*
∠*LOM* = ∠*NMO*	Corresponding angles of congruent triangles are equal.
LO ∥ *MN*	Alternate interior angles
LM ∥ *ON*	Alternate interior angles
LMNO is a parallelogram.	Opposite sides are parallel.

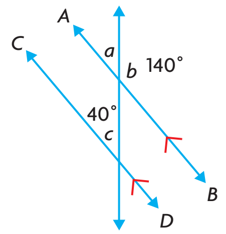
Chapter Review, page 119

1. e.g., The side bars coming up to the handle are parallel and the handle is a transversal.

2. **a)** $\angle a$, $\angle e$; $\angle b$, $\angle g$; $\angle c$, $\angle f$; $\angle d$, $\angle h$
b) No. e.g., The lines are not parallel, so corresponding pairs cannot be equal.
c) 8; e.g., $\angle a$, $\angle b$
d) Yes; $\angle a$, $\angle d$; $\angle b$, $\angle c$; $\angle e$, $\angle h$; $\angle f$, $\angle g$

3. $\angle a = 35°$, $\angle b = 145°$

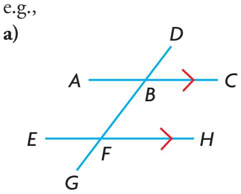
4.



$\angle a + \angle b = 180°$	$\angle a$ and $\angle b$ form a straight angle.
$\angle a = 40°$	Substitution and subtraction
$\angle c = 40°$	Given
$\angle a = \angle c$	Corresponding angles are equal.
$AB \parallel CD$	

5. **a)** $\angle a = 104°, \angle b = 76°, \angle c = 76°$
b) $\angle a = 36°, \angle b = 108°, \angle c = 108°$

6. e.g.,
a)



b) Measure $\angle ABF$ and $\angle BFH$. Measure $\angle DBA$ and $\angle BFE$. Both pairs should be equal.

7. e.g.,

$\angle QRS = \angle RST$	Alternate angles
$\angle QRS = \angle TRS$	Given
$\angle RST = \angle TRS$	Transitive property
$ST = TR$	Isosceles triangle

8. **a)** $x = 40°, y = 95°, z = 45°$
b) $x = 68°, y = 112°, z = 40°$

9. e.g.,

$\angle OPL = \angle POL$ $\angle OQN = \angle NOQ$	$\triangle OPL$ and $\triangle NOQ$ are isosceles.
$\angle PLO = 180° - (\angle POL + \angle OPL)$ $\angle QNO = 180° - (\angle NOQ + \angle OQN)$	The sum of the angles in each triangle is 180°.
$\angle PLO = 180° - 2\angle POL$ $\angle QNO = 180° - 2\angle NOQ$	Substitute $\angle OPL = \angle POL$ and $\angle OQN = \angle NOQ$.
$\angle PLO + \angle QNO = 180° - 90°$ $\angle PLO + \angle QNO = 90°$	$\angle PLO$ and $\angle QNO$ are the two acute angles in the right triangle LMN.
$(180° - 2\angle POL) + (180° - 2\angle NOQ) = 90°$	Substitute the expressions for $\angle PLO$ and $\angle QNO$.
$\angle POL + \angle NOQ = 135°$	Isolate $\angle POL + \angle NOQ$ in the equation.
$\angle POQ = 45°$	$\angle POQ$, $\angle POL$, and $\angle NOQ$ are supplementary because they form a straight line.

10. **a)** 2340°
b) e.g., The sum of the 15 exterior angles is 360°, so each exterior angle is $360° \div 15 = 24°$.

11. e.g.,

$\angle ABC = 108°, \angle BCD = 108°, \angle CDE = 108°$	The angles in a regular pentagon are 108°.
$\angle BCA + \angle BAC = 180° - 108°$	The sum of the angles of $\triangle ABC$ is 180°.
$2\angle BCA = 72°$ $\angle BCA = 36$	$\triangle ABC$ is isosceles with $\angle BCA = \angle BAC$.
$\angle ACD = \angle BCD - \angle BCA$ $\angle ACD = 108° - 36°$ $\angle ACD = 72°$	$\angle BCA + \angle ACD = \angle BCD$
$AC \parallel ED$	$\angle ACD = 72°$ and $\angle CDE = 108°$ are supplementary interior angles on the same side of the transversal CD.

12. $\triangle ABC \cong \triangle YXZ$ by ASA; $\triangle QRS \cong \triangle HJI$ by SAS; $\triangle DEF \cong \triangle MLN$ by SAS

13. **a)** $BC = XY$ or $\angle A = \angle Z$
b) $QR = GH$ or $\angle P = \angle F$

14. e.g.,

$XY = WZ$	Given
$YO = ZO$	Property of radii of a circle
$WO = XO$	Property of radii of a circle
$\triangle XYO \cong \triangle WZO$	SSS

15. e.g.,

$QT = SR$	Given
$\angle QTR = \angle SRT$	Given
$TR = TR$	Common side
$\triangle RTS \cong \triangle TRS$	SAS
$QR = ST$	$\triangle RTS \cong \triangle TRS$

16. e.g.,

$\angle DAB = \angle CBA$	Right angles are equal.
$\angle DBA = \angle CAB$	Given
$AB = AB$	Common side
$\triangle DAB \cong \triangle CBA$	ASA
$\angle ADB = \angle BCA$	$\triangle DAB \cong \triangle CBA$

17. e.g.,

$LO = NM$	Given
$ON = ML$	Given
$LN = LN$	Common side
$\triangle LON \cong \triangle NML$	$SSS \cong$
$\angle OLN = \angle MNL$	$\triangle LON \cong \triangle NML$
$OL \parallel MN$	Alternate interior angles $\angle OLN = \angle MNL$

Answers

18. **a)** Step 3 is incorrect. $\triangle ADE$ is isosceles, but this cannot be used to show the equality of angles that are not part of the triangle.

b) e.g.,

$AB = AC$	Given
$AD = AE$	Given
$\angle A = \angle A$	Common angle
$\triangle ABE \cong \triangle ACD$	SAS
$\angle DBF = \angle ECF$	$\triangle ABE \cong \triangle ACD$
$DB = EC$	Given
$\angle DFB = \angle EFC$	Opposite angles
$\angle FDB = 180° - (\angle DBF + \angle DFB)$	Sum of angles in a triangle is 180°
$\angle FEC = 180° - (\angle ECF + \angle CFE)$	Sum of angles in a triangle is 180°
$\angle FEC = 180° - (\angle DBF + \angle DFB)$	Substitution
$\angle FDB = \angle FEC$	Transitive property
$\triangle DBF \cong \triangle ECF$	ASA
$BF = CF$	$\triangle DBF \cong \triangle ECF$

19. e.g.,

$DE = DG$	Given
$EF = GF$	Given
$DF = DF$	Common side
$\triangle DEF \cong \triangle DGF$	SSS
$EF = GF$	Given
$\angle EFH = \angle GFH$	$\triangle DEF \cong \triangle DGF$
$FH = FH$	Common side
$\triangle EFH \cong \triangle GFH$	SAS
$EH = GH$	$\triangle EFH \cong \triangle GFH$

Cumulative Review Chapters 1–2, page 124

1. e.g.,

a) A conjecture is a testable expression that is based on available evidence but is not yet proven.

b) Inductive reasoning involves looking at examples, and by finding patterns and observing properties, a conjecture may be made.

c) The first few examples may have the same property, but that does not mean that all other cases will have the same property. e.g., Conjecture: The difference of consecutive perfect squares is always a prime number.

$2^3 - 1^3 = 7$ $\quad$ $5^3 - 4^3 = 61$
$3^3 - 2^3 = 19$ $\quad$ $6^3 - 5^3 = 91$,
$4^3 - 3^3 = 37$ $\quad$ 91 is not a prime number.

2. Yes, her conjecture is reasonable.

3. One. e.g., Conjecture: All prime numbers are odd numbers. 2 is a prime number but is not odd.

4. Agree. e.g., The triangles across from each other at the point where the diagonals intersect are congruent. This makes the alternate interior angles equal, so the opposite sides are parallel.

5. **a)** Conjecture: The sum of two odd numbers is always an even number.

b) e.g., Let $2n + 1$ and $2k + 1$ represent any two odd numbers.
$(2n + 1) + (2k + 1) = 2n + 2k + 2 = 2(n + k + 1)$
$2(n + k + 1)$ is an even number.

6. e.g.,

Instruction	Result
Choose a number.	x
Double it.	$2x$
Add 9.	$2x + 9$
Add the number you started with.	$2x + 9 + x = 3x + 9$
Divide by 3.	$\frac{(3x + 9)}{3} = x + 3$
Add 5.	$x + 3 + 5 = x + 8$
Subtract the number you started with.	$(x + 8) - x = 8$

7. **a)** The number of circles in the nth figure is $1 + 5(n - 1) = 5n - 4$; there are 71 circles in the 15th figure.

b) Inductive. A pattern in the first few cases was used to come up with a formula for the general case.

8. Let $ab0$ represent the three digit number. Then, $ab0 = 100a + 10b = 10(10a + b)$, which is divisible by 10.

9. e.g., Turn one of the switches on for a short period of time and then turn it off. Turn on another of the switches and leave it on. Enter the room. Check which of the two light bulbs that is off is still warm. This light belongs to the switch that was turned on and then off. The light bulb that is on belongs to the switch that was left on. The last light bulb belongs to the last switch.

10. **a)** $\angle a = 75°$, $\angle b = 105°$, $\angle c = 105°$, $\angle d = 105°$

b) $\angle a = 50°$, $\angle f = 50°$, $\angle b = 55°$, $\angle e = 55°$, $\angle c = 75°$, $\angle d = 75°$

c) $\angle x = 50°$, $\angle y = 60°$

d) $\angle a \doteq 128.6°$, $\angle b \doteq 51.4°$

11. e.g., equal alternate interior angles, $\angle AEF = \angle DFE$.

12. **a)** 540°

b) 108°

c) 360°

13. e.g.,

$LO = MN$	Given
$\angle OLN = \angle MNL$	Alternate angles
$\angle LOM = \angle NMO$	Alternate angles
$\triangle LOP \cong \triangle NMP$	ASA

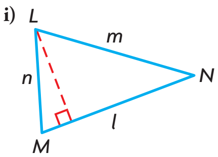
14. e.g.,

$\angle ADC = \angle CEA$	Right angles are equal.
$AC = AC$	Common side
$\angle CAB = \angle ACB$	$\triangle ABC$ is isosceles.
$\angle EAC = 180° - (\angle CEA + \angle ECA)$	Sum of angles in a triangle is 180°
$\angle DCA = 180° - (\angle ADC + \angle DAC)$	Sum of angles in a triangle is 180°
$\angle DCA = 180° - (\angle CEA + \angle ECA)$	Substitution
$\angle EAC = \angle DCA$	Transitive property
$\triangle ADC \cong \triangle CEA$	ASA
$AE = CD$	$\triangle ADC \cong \triangle CEA$

Chapter 3

Lesson 3.1, page 131

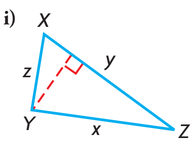
1. **a) i)**



ii) $h = m \sin N, h = n \sin M$

$$\frac{m}{\sin M} = \frac{n}{\sin N}$$

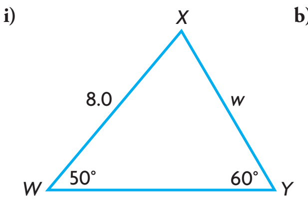
b) i)



ii) $h = z \sin X, h = x \sin Z$

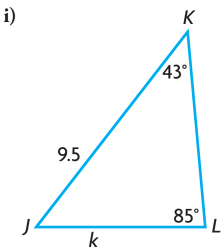
$$\frac{x}{\sin X} = \frac{z}{\sin Z}$$

2. **a) i)**



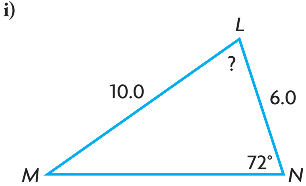
ii) $w = 7.1$

b) i)



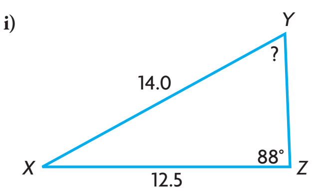
ii) $k = 6.5$

c) i)



ii) $\angle M = 34.8°$

d) i)

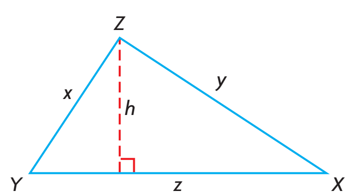


ii) $\angle Y = 63.2°$

3. Agree. $\sin X = \dfrac{h}{y}$ $\qquad \sin Y = \dfrac{h}{x}$

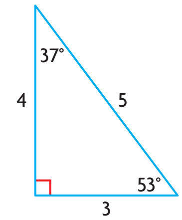
$h = y \sin X \qquad h = x \sin Y$

$\therefore y \sin X = x \sin Y$

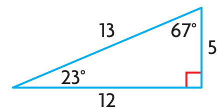


4. e.g., You need two sides and the angle opposite one of the sides or two angles and any side.

5. e.g., Yes, the ratios are equivalent.



$$\frac{3}{\sin 37°} = 5$$
$$\frac{4}{\sin 53°} = 5$$
$$\frac{5}{\sin 90°} = 5$$



$$\frac{5}{\sin 23°} = 13$$
$$\frac{12}{\sin 67°} = 13$$
$$\frac{13}{\sin 90°} = 13$$

Lesson 3.2, page 138

1. $\dfrac{q}{\sin Q} = \dfrac{r}{\sin R} = \dfrac{s}{\sin S}$

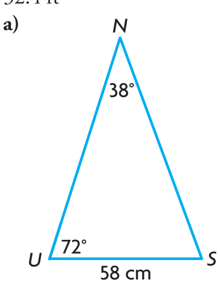
2. **a)** $b = 37.9$ cm **b)** $\theta = 61°$

3. **a)** $d = 21.0$ cm
b) $a = 26.1$ cm, $b = 35.2$ cm
c) $y = 6.5$ cm
d) $\theta = 64°$
e) $\theta = 45°, \alpha = 85°$
f) $\theta = 25°, \alpha = 75°, j = 6.6$ m

4. **a)** e.g., The lake's length is opposite the largest angle of the triangle and must also be the longest side. A length of 36 km would not make it the longest side.
b) 48.7 km

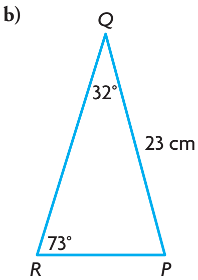
5. 32.4 ft

6. **a)**



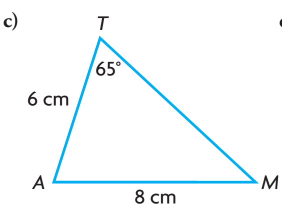
$u = 90$ cm

b)



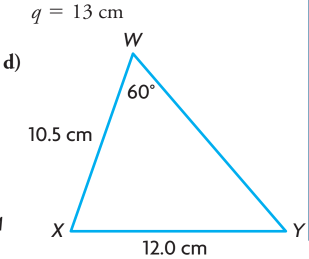
$q = 13$ cm

c)



$\angle M = 43°$

d)



$\angle Y = 49°$

7. $a = 41.9$ m, $t = 44.9$ m, $\angle A = 67°$

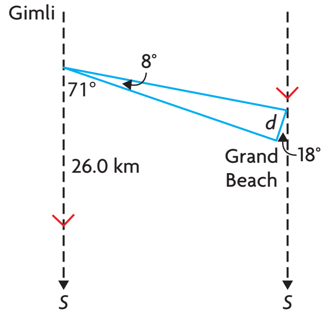
8. **a) i)** $\sin 36.9 = \dfrac{n}{10}, n = 6.0$ cm

ii) $\dfrac{10}{\sin 90°} = \dfrac{n}{\sin 36.9°}, n = 6.0$ cm

b) e.g., Since $\sin 90° = 1$, you can rearrange the sine law formula to give the expression for the sine ratio.

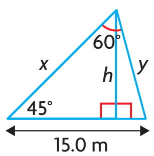
Answers

9. **a)**



b) 3.6 km

10. **a)** e.g.,



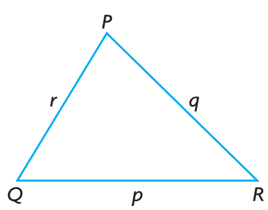
b) The wires are 12.2 m and 16.7 m long, and the pole is 11.8 m high.

11. e.g., Use the Pythagorean theorem to determine the value of q, then use a primary trigonometric ratio to determine $\angle P$. $\sin P = \frac{8}{q} = \frac{8}{10}$
Use the Pythagorean theorem to determine the value of q, then use the sine law to determine $\angle P$. $\frac{8}{\sin P} = \frac{10}{\sin 90°}$

12. 11.4 km

13. 24.8 m

14. e.g.,



a) $\angle P$, $\angle R$, q
b) $\angle P$, q, r

15. Agree. Jim needs to know an angle and its opposite side.

16. e.g., You can determine $\angle R$ since the sum of the three angles of a triangle is 180°; you can use the sine law to determine q and r.

17. 19.7 square units

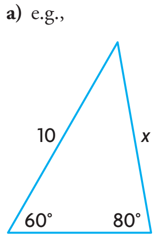
18. 10.2 cm

19. e.g.,
a) $\frac{a}{b}$ **b)** $\frac{\sin A}{\sin C}$ **c)** 1

Mid-Chapter Review, page 143

1. $\frac{x}{\sin X} = \frac{y}{\sin Y} = \frac{z}{\sin Z}$ or $\frac{\sin X}{x} = \frac{\sin Y}{y} = \frac{\sin Z}{z}$

2. **a)** e.g.,



b) $x = 8.8$

3. e.g., Disagree; you can't rearrange Nazir's expression so that f and $\sin F$ are in one ratio and d and $\sin D$ are in the other.

4. **a)** $x = 5.9$ cm, $\theta = 42.9°$
b) $x = 10.6$ cm, $y = 9.7$ cm, $\theta = 62.0°$

5. **a)** $\angle C = 60°$, $b = 12.2$ cm, $c = 13.8$ cm
b) $\angle L = 85°$, $l = 32.9$ cm, $m = 32.7$ cm

6. e.g., The value of either $\angle X$ or $\angle Z$ is needed to solve the triangle.

7. **a)** The tower at B is closer. e.g., The distance from tower B to the fire is length a, which is across from the smaller angle.
b) 3.1 km

8. 631 m

9. **a)** 84.2 cm **b)** 82.3 cm

Lesson 3.3, page 150

1. **a)** No **b)** Yes

2. 13 cm

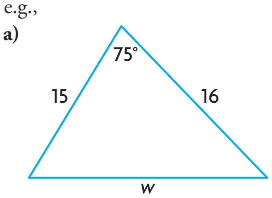
3. $\angle P = 72°$

4. **a)** 6.9 cm **b)** 14.7 cm

5. **a)** 34° **b)** 74°

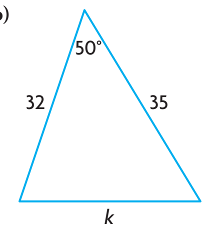
6. e.g.,

a)



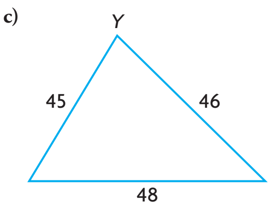
$w = 18.9$

b)



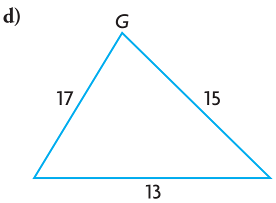
$k = 28.4$

c)



$\angle Y = 63.7°$

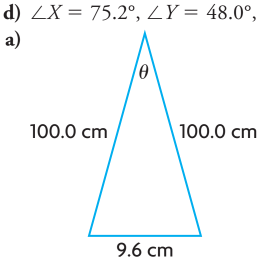
d)



$\angle G = 47.4°$

7. **a)** $f = 6.3$ cm, $\angle D = 45.9°$, $\angle E = 69.1°$
b) $r = 10.1$ m, $\angle P = 38.6°$, $\angle Q = 61.4°$
c) $\angle L = 86.6°$, $\angle M = 56.6°$, $\angle N = 36.8°$
d) $\angle X = 75.2°$, $\angle Y = 48.0°$, $\angle Z = 56.8°$

8. **a)**



b) 5.5°

9. 53.0 cm

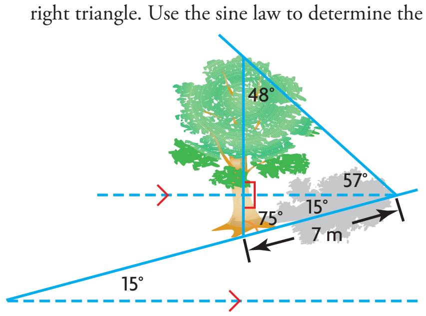
10. e.g., You can use the cosine law; the 70° angle is one of the acute angles across from the shorter diagonal. It is contained between an 8 cm side and a 15 cm side.

11. **a)** **i)** about 17 cm
ii) about 17 cm
b) e.g., The hour and minute hands are the same distance apart at 2:00 and 10:00, and the triangles formed are congruent.

12. No. e.g., When you put the side lengths into the cosine law expression, you do not get $-1 \leq \cos \theta \leq 1$.
13. 34.4 km
14. e.g., Kathryn wants to determine the length of a pond. From where she is standing, one end of the pond is 35 m away. If she turns 35° to the left, the distance to the other end of the pond is 30 m. How long is the pond? Use the cosine law to determine the unknown side length.
15. 423 cm^2
16. area $\doteq$ 8.2 cm^2; perimeter $\doteq$ 10.9 cm
17. e.g., The vertex angle at the handle of the knife is about 110°. Each of the sides of the knife is about 9 cm in length.

Lesson 3.4, page 161

1. **a)** sine law
   b) tangent ratio or sine law
   c) cosine law
2. **a)** part a: $\theta = 83.9°$, part b: $c = 1.9$ cm, part c: $\theta = 39.6°$
   b) e.g., Using a trigonometric ratio is more efficient because you have fewer calculations to do.
3. **a)** Using the cosine law. **b)** 2.5 km
4. 29' 2", 31' 3"
5. **a)** 43.2 m **b)** about 13.3 m
6. **a)** e.g., Use the properties of parallel lines to determine the angle from the shadow up to the horizontal. Subtract that angle from 57° to determine the angle from the horizontal up to the sun. Both of these are angles of right triangles with one side along the tree. Subtract each angle from 90° to determine the third angle in each right triangle. Use the sine law to determine the height of the tree.



   b) 8 m
7. 241.2 m
8. 293.9 m
9. **a)** 11.1 m **b)** 18.8 m
10. **a)** e.g., Connect the centre to the vertices to create congruent isosceles triangles and determine the angles at the centre. In one triangle, use the cosine law to determine the pentagon side length and multiply that answer by five.
    b) 58.8 cm
11. **a)** 879.3 m **b)** about 40 s
12. **a)** 157.0 km
    b) The airplane that is 100 km away will arrive first.
13. 85°, 95°, 85°, 95°
14. 520.2 m; e.g.,
    Step 1 – Determine $\angle BDC$ in $\triangle BDC$.
    Step 2 – Use the sine law to determine CD.
    Step 3 – In $\triangle ADC$, use the tangent ratio to determine h.
15. e.g., Starr and David leave school from the same spot. Starr walks N65°E at 3 km/h while David walks S30°E at 4 km/h. How far apart are they after 20 min? The problem can be solved using the cosine law.
16. **a)** 63° **b)** 52°
17. 50.0 cm^2

Chapter Self-Test, page 166

1. **a)** $\theta = 42.6°$ **b)** c = 2.4 cm
2. $\angle R = 52.0°$, $p = 25.0$ cm, $q = 18.9$ cm
3. 117.0 km
4. 11.6 cm
5. 130.5 m
6. 28.3 m^2
7. e.g., If the angle is the contained angle, then use the cosine law. If it is one of the other angles, use the sine law to determine the other non-contained angle, calculate the contained angle by subtracting the two angles you know from 180°, then use the cosine law.
8. e.g., When two angles and a side are given, the sine law must be used to determine side lengths. When two sides and the contained angle are given, the cosine law must be used to determine the third side.

Chapter Review, page 168

1. No. e.g., $\angle C = 90°$, so this will be a right triangle.
2. Part d) is incorrect.
3. **a)** $x = 23.7$ m **b)** $\theta = 61.9°$
4. $\angle C = 55°$, $a = 9.4$ cm, $b = 7.5$ cm
5. 295.4 m
6. Part a) is not a form of the cosine law.
7. **a)** $x = 7.6$ m **b)** $\theta = 68.2°$
8. $a = 12.2$ cm, $\angle B = 44.3°$, $\angle C = 77.7°$
9. 58°
10. 11.1 m
11. 584 km
12. 5.5 km, N34.9°W

Chapter 4

Lesson 4.1, page 182

1. **a)** false **c)** false **e)** true
b) false **d)** false **f)** false

2. **a)** iv **b)** i **c)** iii **d)** ii

3. **a)** $\sqrt{432}$ is an entire radical; $5\sqrt[3]{2}$ is a mixed radical
b) $\sqrt{432} = 12\sqrt{3}$; $5\sqrt[3]{2} = \sqrt[3]{250}$

4. **a)** $6\sqrt{2}$ **c)** $2\sqrt[3]{5}$
b) $10\sqrt{6}$ **d)** $5\sqrt[3]{2}$

5. **a)** $20\sqrt{10}$ **c)** $-2\sqrt[3]{9}$
b) $-9\sqrt{35}$ **d)** $6\sqrt[3]{3}$

6. **a)** $2^4 \cdot 3^5$ **c)** $2^7 \cdot 5^3$
b) $2^5 \cdot 5^5$ **d)** $5^4 \cdot 3^3$

7. e.g.,
a) $\sqrt{14} \cdot \sqrt{14}$ **c)** $\sqrt[3]{8} \cdot \sqrt[3]{8}$
b) $\sqrt{60} \cdot \sqrt{60}$ **d)** $\sqrt[3]{125} \cdot \sqrt[3]{27}$

8. **a)** $\sqrt{2^4 \cdot 2^2}$ **b)** $\sqrt{2^4 \cdot 3^2 \cdot 5^2}$ **c)** $\sqrt[3]{2^6 \cdot 5^3}$

9. Kenny's mistake was in thinking that $\sqrt{16} = -4$. $\sqrt{16} = 4$, the principal root.

10. **a)** e.g., 6.8; 6.86 **c)** e.g., 28; 28.11
b) e.g., 201; 202.48 **d)** e.g., 9.7; 9.65

11. **a)** $\sqrt{180}$ **c)** $\sqrt[3]{896}$
b) $\sqrt{1008}$ **d)** $\sqrt[3]{-108}$

12. **a)** $\sqrt{16}, \sqrt{48}, \sqrt{14}, \sqrt{18}, \sqrt{80}$
b) $\sqrt{14}, 4, 3\sqrt{2}, 4\sqrt{3}, 4\sqrt{5}$

13. Disagree. The mixed radicals cannot be added because the index of the radicals are different.

14. e.g., 64, 729

15. $20\sqrt{2}, 10\sqrt{8}, 5\sqrt{32}, 4\sqrt{50}, 2\sqrt{200}$; $20\sqrt{2}$ is in lowest form

16. **a)** 90 m/s **b)** 324 km/h

17. 67 km/h

18. **a)** $\sqrt{2^4 \cdot 5^3 \cdot 7} = 20\sqrt{35}$
b) No, it could not be a square with area exactly $\sqrt{14000}$ m². For the playground to be a square, the side lengths would not be a whole number of metres and the area would be approximately equal to $\sqrt{14000}$ m².

19. e.g., 5, 12, 13 or 7, 24, 25; I looked for perfect squares that had perfect square sums.

20. **a)** true **b)** true

Lesson 4.2, page 188

1. **a)** like **c)** like
b) unlike **d)** like

2. **a)** $9\sqrt{6}$ **c)** $6\sqrt{2}$
b) $4\sqrt{3}$ **d)** $-2\sqrt{10}$

3. $8\sqrt{3}$

4. **a)** $14\sqrt{2}$ **b)** 0

5. **a)** $11\sqrt{2}$ **c)** $20 + 9\sqrt{2}$
b) $13\sqrt{3} + 6\sqrt{5}$ **d)** $11\sqrt{5} + 8\sqrt{15}$

6. **a)** $-4\sqrt{10}$ **c)** $13\sqrt{2} - 22$
b) $-3\sqrt{3}$ **d)** $9\sqrt{2} - 18\sqrt{5} - 30\sqrt{3}$

7. **a)** $(11\sqrt{2} + 3\sqrt{7})$ cm **b)** 23.5 cm

8. e.g., Yes, the sum of any two sides is greater than the third side.

9. **a)** $8\sqrt{2} + 9\sqrt{3}$ **b)** $8\sqrt{3} + 10\sqrt{7}$

10. $(68\sqrt{2} + 80)$ cm

11. $8\sqrt{5}$ m

12. $5\sqrt{10}$ m

13. $3\sqrt{5}$ m

14. $17\sqrt{2}$

15. $3\sqrt{5} + 7\sqrt{6}$

16. e.g., His error is in going from the second last line to the last line, where he should not have added unlike radicals. The correct answer is $24\sqrt{6} + 12\sqrt{3}$.

17. e.g., The number of terms will be equal to the number of unlike radicals. For example,
$\sqrt{108} + \sqrt{50} + \sqrt{16} - \sqrt{8} = 6\sqrt{3} + 5\sqrt{2} + 4 - 2\sqrt{2}$
There are three unlike radicals when expressed in lowest form, so there are three terms in the final answer:
$6\sqrt{3} + 3\sqrt{2} + 4$

18. $6\sqrt{6}$

19. **a)** $-\sqrt{2}$ **b)** $5\sqrt{3}$ **c)** $17\sqrt{5}$

20. e.g., They are the same in that radicals can be added and subtracted. This is done by adding and subtracting the number that precedes the radical, just as the coefficient of the variable in algebraic expressions are added and subtracted. They are different in that radical expressions may be written as mixed radicals or entire radicals and thus expressed in different forms.

21. 2 times longer

Lesson 4.3, page 198

1. **a)** $\sqrt{30}$ **c)** $12\sqrt{2}$
b) $4\sqrt{15}$ **d)** $224\sqrt{6}$

2. **a)** $\frac{\sqrt{5}}{5}$
b) e.g., It is the same as multiplying the radical by 1.

3. $\sqrt{16}; \frac{8}{2}; \frac{\sqrt{16}\sqrt{4}}{\sqrt{4}}$

4. **a)** $\sqrt{288}; 12\sqrt{2}$ **c)** $-\sqrt{1620}; -18\sqrt{5}$
b) $\sqrt{5400}; 30\sqrt{6}$ **d)** $\sqrt{1176}; 14\sqrt{6}$

5. **a)** $14\sqrt{3} + 21$ **d)** $16\sqrt{6}$
b) $4\sqrt{5} - 5\sqrt{2}$ **e)** $30 + 6\sqrt{10} + 5\sqrt{6} + 2\sqrt{15}$
c) $2\sqrt{15} - 24\sqrt{2}$ **f)** $212 - 40\sqrt{6}$

6. **a)** e.g., $10\sqrt{1296} = 360$; $4(3) \cdot 3(2) \cdot 5 = 360$
b) associative, commutative

7. **a)** e.g., $\sqrt{192} = \sqrt{64}\sqrt{3}$; $\sqrt{4800} = \sqrt{1600}\sqrt{3}$

b) $\sqrt{192} = 8\sqrt{3}$; $\sqrt{4800} = 40\sqrt{3}$; e.g., It helped to see the perfect squares.

8. Figure A

9. **a)** Figure A

b) e.g., No, I expressed both areas as entire radicals so that I could compare them:

$\sqrt{2592} > \sqrt{2500}$

10. e.g., The second line is incorrect:

$\sqrt{8} \neq \sqrt{2} + \sqrt{2} + \sqrt{2} + \sqrt{2}$

The correct solution is

$\sqrt{8} = \sqrt{2} \cdot \sqrt{2} \cdot \sqrt{2}$

$\sqrt{8} = 2\sqrt{2}$

11. **a)** Steve is incorrect.

b) $2 - 2\sqrt{2} + 1 = 3 - 2\sqrt{2}$

12. **a)** $T = 2\pi\sqrt{2}$ **b)** 8.89 s

13. **a)** $\frac{\sqrt{14}}{2}$ **c)** $-2\sqrt{3}$

b) $\frac{-\sqrt{5}}{20}$ **d)** $\frac{3}{2}$

14. **a)** 2 **c)** $-3\sqrt{5}$

b) $-4\sqrt{3}$ **d)** -7

15. Agree, $\sqrt{0.16}$ can be written as $\sqrt{\frac{16}{100}}$.

16. **a)** $\frac{5\sqrt{30}}{3}$ **c)** $\frac{3 + \sqrt{3}}{3}$

b) $\frac{2\sqrt{10} - 5}{5}$ **d)** $\frac{20 + 2\sqrt{15}}{15}$

17. **a)** $40\sqrt{10}$ m/s **b)** 40 m/s

18. $\frac{\sqrt{42}}{7}$

19. **a)** $3\sqrt{2}$ **b)** $7\sqrt{5}$

20. B

21. **a)** e.g., You should keep numbers as radicals because your answer remains exact. For example,

$\sqrt{3} \doteq 1.73$

but

$1.73^2 = 2.9929$

$1.73^2 \neq 3$

whereas

$(\sqrt{3})^2 = 3$

b) 12

22. e.g., The rules that apply to multiplying and dividing algebraic expressions are similar to the ones for radicals. When simplifying these expressions, we multiply/divide variables and multiply/divide coefficients. For example,

$3\sqrt{2} \cdot 6\sqrt{5} = 18\sqrt{10}$

23. $\frac{1}{\sqrt[3]{3}} \cdot \frac{\sqrt[3]{3}}{\sqrt[3]{3}} \cdot \frac{\sqrt[3]{3}}{\sqrt[3]{3}} = \frac{\sqrt[3]{9}}{3}$

Mid-Chapter Review, page 203

1. **a)** 9 **c)** -4 **e)** 3

b) 15.8 **d)** -10.1 **f)** -5

2. **a)** $4\sqrt{2}$ **b)** $8\sqrt{2}$

c) cannot be expressed as a mixed radical

d) $-3\sqrt{6}$

e) $3\sqrt[3]{4}$

f) $-8\sqrt[3]{2}$

3. **a)** $\sqrt{75}$ **d)** $-\sqrt{32}$

b) $\sqrt{484}$ **e)** $\sqrt[3]{648}$

c) $\sqrt[3]{-13824}$ **f)** $\sqrt[3]{-1728}$

4. $4\sqrt[3]{-27}, -\sqrt{121}, -\sqrt{101}, -2\sqrt{25}, -2\sqrt[3]{8}$

5. The design with side lengths of 140 cm will use more stained glass.

6. **a)** $7\sqrt{3}$ **d)** $7\sqrt{7}$

b) $18\sqrt{2}$ **e)** $24\sqrt{2}$

c) $8\sqrt{5}$

7. **a)** $-2\sqrt{6}$ **d)** $-8\sqrt{10}$

b) -18 **e)** $-14\sqrt{3}$

c) $-11\sqrt{3}$

8. **a)** $5\sqrt{3} + 5\sqrt{6}$ **d)** $9\sqrt{2}$

b) $2 + 3\sqrt{3}$ **e)** $8\sqrt{3} - 5\sqrt{2}$

c) $\sqrt{7}$

9. $20\sqrt{6}$ cm by $10\sqrt{6}$ cm

10. **a)** $2\sqrt{14}$ **d)** $14\sqrt{5}$

b) $2\sqrt{30}$ **e)** $-3\sqrt{5}$

c) $15\sqrt{3}$

11. **a)** $2\sqrt{2}$ **d)** $14\sqrt{5}$

b) -6 **e)** $-3\sqrt{5}$

c) $-\frac{\sqrt{2}}{2}$

12. **a)** $4\sqrt{2} + 5\sqrt{6}$ **c)** $5\sqrt{3} + 8\sqrt{30} + 5\sqrt{7} + 8\sqrt{70}$

b) $-168\sqrt{3} + 14\sqrt{6}$ **d)** -33

13. $\sqrt{58}$ m by $\sqrt{58}$ m

Lesson 4.4, page 211

1. **a)** $x \in R$ **c)** $x \geq -3, x \in R$

b) $x \geq 0, x \in R$ **d)** $x > 0, x \in R$

2. **a)** $x \in R$; $6\sqrt{5x^2}$

b) $x \in R$; $3x$

c) $x \geq 0, x \in R$; $4x\sqrt{3x}$

d) $x \geq 0, x \in R$; $-6x^3\sqrt{2x}$

3. **a)** $x \geq 0, x \in R$; $7\sqrt{2x}$

b) $x \geq 0, x \in R$; $54x\sqrt{3x}$

c) $x \geq 0, x \in R$; $10x$

d) $x > 0, x \in R$; $-3x^2$

4. **a)** $x \geq 0, x \in R$; $5\sqrt{2x^5}$

b) $x \geq 0, x \in R$; $-20x^2\sqrt{2}$

c) $x > 0, x \in R$; $-3x$

d) $x > 0, x \in R$; 2

5. **a)** Step 1: x^2

Step 2: x

Step 3: $7x + 3x$

Answers

b) e.g., Step 1: Express $\sqrt{x^3}$ as $\sqrt{x^2}\sqrt{x}$.
Step 2: Simplify $\sqrt{x^2}$.
Step 3: Simplify by taking a common factor.

6. **a)** $x \geq 0, x \in \mathrm{R}; 0$
b) $x \geq 0, x \in \mathrm{R}; 2x^2 + 8x^4$
c) $x > 0, x \in \mathrm{R}; \dfrac{3\sqrt{x} - x\sqrt{x}}{x}$
d) $x > 0, x \in \mathrm{R}; x\sqrt{2}$

7. e.g., Dividing radicals and rationalizing radical expressions are similar in that they both use the rules of radicals. They are different in that rationalizing the denominator uses multiplication of a radical in the form of "1."

8. **a)** $x \geq 0, x \in \mathrm{R}; 10x\sqrt{2}$
b) $x \geq 0, x \in \mathrm{R}; 2x + 4x\sqrt{2x}$
c) $x \geq 0, x \in \mathrm{R}; -3x^2 + 12x\sqrt{x}$
d) $x \geq 0, x \in \mathrm{R}; x + 7\sqrt{x} + 10$

9. **a)** $x \geq 0, x \in \mathrm{R}; 10\sqrt{x}$
b) $x \in \mathrm{R}; 2x^2$
c) $y \geq 0, y \in \mathrm{R}; -6y^2 + 12\sqrt{y}$
d) $y \geq 0, y \in \mathrm{R}; 25 - 10\sqrt{y} + y$

10. **a)** $x > 0, x \in \mathrm{R}; x^3$
b) $x > 0, x \in \mathrm{R}; 2x$
c) $x > 0, x \in \mathrm{R}; 5x$
d) $x \neq 0, x \in \mathrm{R}; 2$

11. **a)** $x \geq 9, x \in \mathrm{R}$ **c)** $x \geq -2, x \in \mathrm{R}$
b) $x \geq -4, x \in \mathrm{R}$ **d)** $x \geq \frac{2}{3}, x \in \mathrm{R}$

12. **a)** $\sqrt{5}$ **b)** $\sqrt{x}$ **c)** $\sqrt{7x}$ **d)** $\sqrt{x}$

13. e.g., Multiply the numerator and denominator by $\sqrt{x}$.

14. **a)** He is incorrect. e.g., Only factors can be eliminated.
b) e.g., Expand and then try to factor and/or simplify.
c) $s \geq 26, s \in \mathrm{R}$

15. $x > 0, x \in \mathrm{R}; \dfrac{(9 - 2x^2)\sqrt{x}}{x}$

16. e.g., They are similar because in algebraic expressions you multiply coefficients and multiply variables. The same applies to radicals. Multiply the values preceding the radicals and multiply the terms inside the radicals. For example,
$3x \cdot 2x = 6x^2$ and
$3\sqrt{x} \cdot 2\sqrt{x} = 6\sqrt{x^2}$

17. She is incorrect. e.g., According to the order of operations, she must apply the exponents, and then add. So, she cannot simplify as she did.

Lesson 4.5, page 215

1. **a)** $x = 49$ **c)** $x = 10$
b) $x = 29$ **d)** $x = 28$

2. $A = 2.3$ m^2

3. $d = 0.08$ km

4. $V = 3.82$ m^3

5. **a)** Let x represent the number.
$\sqrt{2x + 5} = 7$
b) $x = 22$
c) $\sqrt[3]{2x + 5} = 7; x = 169$

Lesson 4.6, page 222

1. **a)** $x \geq 0, x \in \mathrm{R}; x = 16$ **c)** $x \geq -1, x \in \mathrm{R}; x = 3$
b) $x \geq 0, x \in \mathrm{R}; x = 36$ **d)** $x \geq -3, x \in \mathrm{R}; x = 13$

2. **a)** $x \in \mathrm{R}; x = -27$ **c)** $x \in \mathrm{R}; x = -12$
b) $x \geq 0, x \in \mathrm{R}; x = 12.5$ **d)** $x \geq -2, x \in \mathrm{R}; x = 16$

3. She is correct. e.g., I solved the original equation, verified my result, and found that the only root, 8, is an extraneous root.

4. **a)** $x \geq 0, x \in \mathrm{R}; x = 4$ **b)** $x \in \mathrm{R}; x = 1$

5. **a)** Square both sides of the equation.
b) Subtract 5 from both sides of the equation.
c) Cube both sides of the equation.
d) Add 1 to both sides of the equation.

6. **a)** $x \geq 3, x \in \mathrm{R}; x = 28$ **c)** $x \geq -\frac{3}{5}, x \in \mathrm{R}; x = \frac{109}{20}$
b) $x \in \mathrm{R}; x = 5$ **d)** $x \geq \frac{2}{3}, x \in \mathrm{R}; x = 22$

7. 7200 W

8. **a)** $x \geq -\frac{3}{2}, x \in \mathrm{R}; x = 4$
b) $x \in \mathrm{R}; x = 7$
c) $x \geq -\frac{3}{5}, x \in \mathrm{R}$; no solution; 1 is an extraneous root
d) $x \leq \frac{11}{2}, x \in \mathrm{R}; x = -8$

9. $\sqrt{x - 1} = -2$; no solution; 5 is an extraneous root

10. Agree. e.g., The first two equations have the same solution, but the third equation has no solution (the left side is greater than or equal to zero and the right side is negative).

11. 19.91 m

12. $818

13. 1 158 105.6 W

14. 1.41 m

15. $x \geq -\frac{5}{2}, x \in \mathrm{R}; x = -\frac{5}{2}, \frac{5}{2}$

16. e.g., $\sqrt{x + 1} = 5$
Isolate the radical if necessary, then square both sides.
$x + 1 = 25$
Solve for x.
$x = 24$

17. $x \geq -\frac{5}{2}, x \in \mathrm{R}; x = \frac{7}{10}$

Chapter Self-Test, page 225

1. **a)** $14\sqrt{6}$ **c)** $6\sqrt[3]{6}$
b) $-8\sqrt{14}$ **d)** $8\sqrt[3]{-5}$

2. least to greatest: $4\sqrt{5}, \sqrt[3]{1000}, 3\sqrt{12}, \sqrt{121}, 12\sqrt{2}$

3. **a)** $4\sqrt{3} + 2\sqrt{2}$ **b)** $\sqrt{11} - 8\sqrt{3}$

4. **a)** $-30\sqrt{2}$
b) $-18\sqrt{3} + 6\sqrt{30}$
c) $x \geq 0, x \in \mathrm{R}; 9x + 12\sqrt{x} + 4$

5. a) $3\sqrt{5}$ b) $\frac{3\sqrt{35}}{5}$ c) $x > 0, x \in \mathrm{R}; 3x^2$

6. a) $x \in \mathrm{R}; 6x^3\sqrt{2}$

b) $x \geq 0, x \in \mathrm{R}; -6x^3\sqrt{x}$

7. $1.4\ \mathrm{m}^2$

8. e.g., To ensure the radical has meaning, it is important to state restrictions (i.e., it is not possible to find the square root of a negative number). To do this, ensure that the radicand is greater than or equal to zero. For example,

i) $\sqrt{x}$ ii) $\sqrt{x+3}$

The restrictions for these are:

i) $x \geq 0$ ii) $x + 3 \geq 0$, so $x \geq -3$

9. a) $x \geq -\frac{5}{4}, x \in \mathrm{R}; x = -1$

b) No; e.g., I verified the root in the original equation.

Chapter Review, page 228

1. a) $6\sqrt{2}$ c) $2\sqrt{10}$

b) $10\sqrt{6}$ d) $5\sqrt[3]{2}$

2. a) $\sqrt{180}$ c) $\sqrt{224}$

b) $\sqrt{1008}$ d) $\sqrt[3]{-108}$

3. a) $6 + \sqrt{42}$ c) $8\sqrt{26} - 17\sqrt{2}$

b) $6\sqrt{2} + 12\sqrt{3} + 4\sqrt{6}$ d) $36 - 24\sqrt{3} - 30\sqrt{6}$

4. a) $12\sqrt{7}$ c) $-80\sqrt{3}$

b) $75\sqrt{10}$ d) $56\sqrt{3}$

5. a) $24 + 12\sqrt{3}$ c) $2\sqrt{30} - 48$

b) $2\sqrt{5} - 5\sqrt{3}$ d) $18\sqrt{6} + 8$

6. The error occurred in going from the second line to the third line. Square roots of sums cannot be simplified by taking the square root of each term separately. The correct result is $2\sqrt{3}$.

7. a) $x \geq 0, x \in \mathrm{R}; 4x^5\sqrt{2}$

b) $x > 0, x \in \mathrm{R}; -4x$

c) $x \geq 0, x \in \mathrm{R}; -\frac{64x}{3}$

d) $x > 0, x \in \mathrm{R}; \frac{\sqrt{30}}{9}$

8. 33.4 m

9. a) $x \geq 0, x \in \mathrm{R}; x = 121$ c) $x \geq 0, x \in \mathrm{R}; x = \frac{9}{7}$

b) $x \geq -3, x \in \mathrm{R}; x = 193$ d) $x \geq \frac{2}{5}, x \in \mathrm{R}; x = \frac{578}{5}$

10. a) $x \geq -\frac{16}{3}, x \in \mathrm{R}$; no solution; 3 is an extraneous root

b) $x \in \mathrm{R}; x = \frac{71}{2}$

c) $x \geq -4, x \in \mathrm{R}; x = -1$

d) $x \leq \frac{11}{3}, x \in \mathrm{R}$; no solution; 3 is an extraneous root

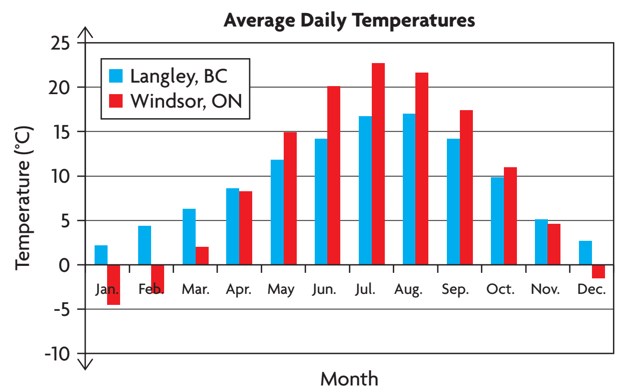
11. a) $x \leq -2, x \geq 2, x \in \mathrm{R}$

b) Jenny made her mistake in step 2 when she forgot to square the right side of the equation.

Chapter 5

Lesson 5.1, page 239

1. a)



b)

	Langley, BC (°C)	Windsor, ON (°C)
Range	14.8	27.2
Mean	9.4	9.4
Median	9.2	9.6

c) e.g., The mean temperature for each city is the same, and the medians are close; however, the temperature in Windsor has a much greater range: it gets colder in winter and warmer in summer.

d) e.g., if you were living in one of the locations and moving to the other location

2. a)

	Unit 1 Test (%)	Unit 2 Test (%)
Range	24	61
Mean	71.2	71.2
Median	73	73
Mode	73	73

b) e.g., The class performed better on the Unit 1 test because the range of scores was smaller, with the mean, median, and mode being equal.

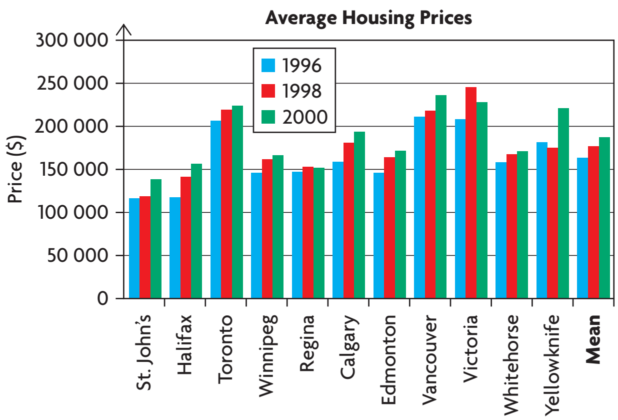
c) e.g., The modes were not very useful to compare in this context because they only tell me which mark occurred most often, not which class performed better.

3. a) e.g.,

	1996 ($)	1998 ($)	2000 ($)
Range	95 567	127 616	86 581
Mean	163 440	176 937	187 433
Median	157 677	167 396	172 503

The data distribution is scattered fairly widely during each year; some cities are much lower or much higher than the mean.

Answers

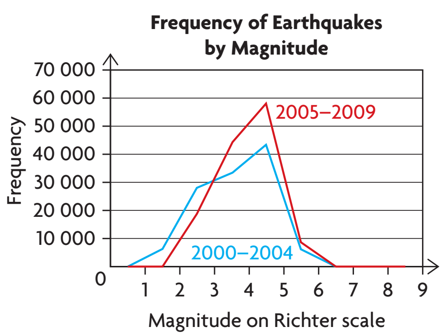


The range between the maximum and minimum average prices in the 11 cities is the greatest in 1998, so that year some prices were much lower than average and some were much higher. Both the mean and the median of the average price in the 11 cities has steadily increased over the 5-year period. In all the cities except for Regina and Victoria, there has been an increase in price over the 5-year period. Also, Yellowknife has had the greatest increase in average price over the 5-year period.

b) e.g., if you were comparing housing costs in cities you are contemplating moving to

Lesson 5.2, page 249

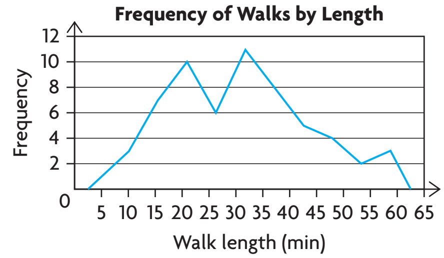
1. **a)**



b) e.g., From 2005 to 2009, there were more earthquakes than from 2000 to 2004. The earthquakes in 2005–2009 tended to be of greater magnitude than those in 2000–2004. 2000–2004 had many more earthquakes that rated less than 3.0, although both periods had roughly the same number of earthquakes that rated more than 7.0.

2. **a)** 10–15 min interval

b) e.g., Most of the data is distributed in the 20–25 min interval and 30–35 min interval.

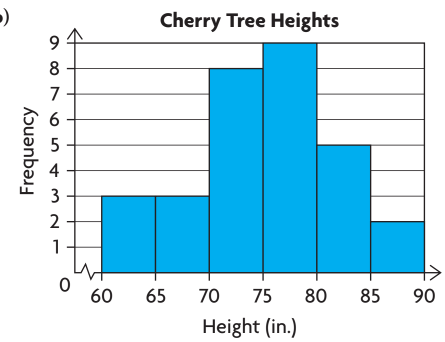


3. e.g.,

a)

Tree Height (in.)	Frequency
60–65	3
65–70	3
70–75	8
75–80	9
80–85	5
85–90	2

b)



c) The ranges of heights 70–75 inches and 75–80 inches occur most frequently. The range of heights 60–65 inches occurs least frequently.

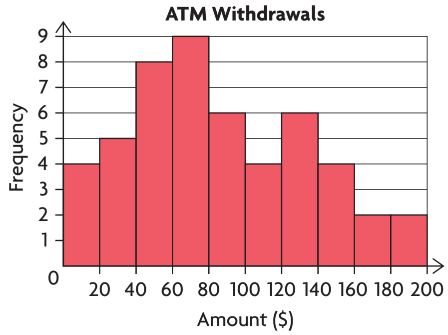
4. e.g.,

a) Most withdrawals are multiples of 20. An interval width of 20 would give a good representation of the distribution of the data.

b)

Withdrawal ($)	Frequency
0–20	4
20–40	5
40–60	8
60–80	9
80–100	6
100–120	4
120–140	6
140–160	4
160–180	2
180–200	2

c)



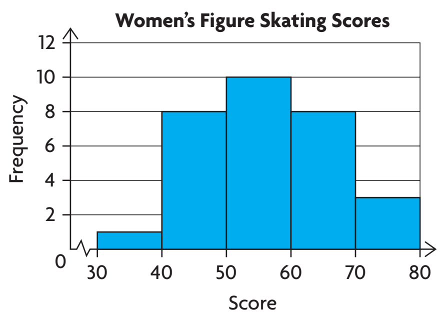
d) There are a lot more withdrawals under $100 than there are over $100. Withdrawals between $40 and $80 are the most frequent. Not many people made withdrawals over $160.

5. e.g,

a)

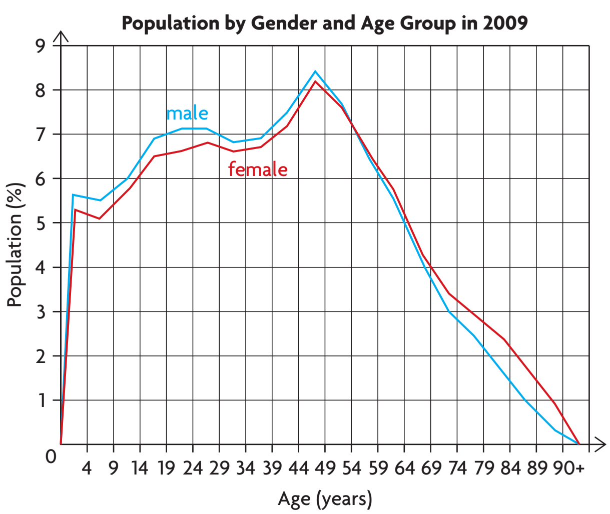
Final Scores	Frequency
30–40	1
40–50	8
50–60	10
60–70	8
70–80	3

b)



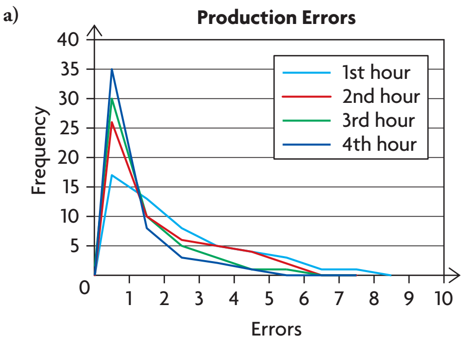
c) No. It shows that three women scored between 70 and 80, but it does not show the range of scores for a top-five placement.

6. a)



b) e.g., There are more males than females for all age groups up to 54 years. Starting at age 55, there are more women than men.

7. a)



b) e.g., As the day progresses, the number of errors on a vehicle decreases. Fewer vehicles have large numbers of errors.

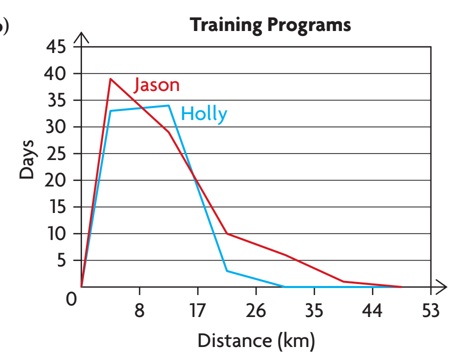
8. e.g.,

a) I chose interval sizes that created five interval spaces that worked for both tables.

Holly's Program	
Kilometres	**Frequency**
0–8	33
8–17	34
17–26	3
26–35	0
35–44	0

Jason's Program	
Kilometres	**Frequency**
0–8	39
8–17	29
17–26	9
26–35	6
35–44	1

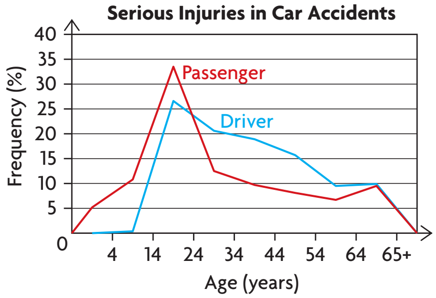
b)



c) Holly's program involves more short distance running, while Jason's program involves more long distance running.

Answers

9.



e.g., Younger drivers are involved in more accidents where there are serious injuries. Also, the greatest number of serious injuries for passengers is in the 15 to 24 age group; perhaps these passengers were in the same accidents as the young drivers who were seriously injured (i.e., out driving with friends).

10. e.g., Using intervals of equal width enables you to see the distribution more easily and to compare the data more effectively.

11. e.g.,

a) Grouping raw data into intervals makes it easier to interpret the data accurately and to see the distribution. It also makes the data more manageable.

b) Histograms compare data intervals side by side using bars, while frequency polygons compare data intervals using lines. Frequency polygons are useful when comparing two or more sets of data, because you can easily combine them on the same graph, making it easier to see differences or similarities in the data sets.

12. e.g.,

a) 5116. I eliminated all rows in the table with a frequency of 0. Then I determined the midpoint for each remaining interval. Next, I multiplied the frequency of each row by the midpoint to estimate the total population for each row. I determined the mean of the products.

b) 3115. The city with the median population is the 76th one, which occurs in the first row of the table. The 76th city out of 122 might have a population of

$$\frac{76}{122} \cdot 5000 = 3114.754\ldots \text{ or } 3115.$$

c) I assumed that 61 cities would be below 2500 and 61 cities would be between 2500 and 5000. Since 75 cities have a population of less than 1700, the estimates for both the mean and the median are higher than they should be.

Lesson 5.3, page 261

1. **a), b)** class A: 14.26; class B: 3.61

c) Class B has the most consistent marks over the first five tests since it has the lowest standard deviation.

2. mean: 130.42 points; standard deviation: 11.51 points

3. **a)** mean: 130.36 points; standard deviation: 12.05 points

b) e.g., Ali's mean and standard deviation are close to his team's. He is an average player on his team.

4. e.g.,

a) The mean number of beads in company B's packages is much less consistent than the mean number of beads in company A's packages.

b) company A

5. Group 1: mean: 71.9 bpm; standard deviation: 6.0 bpm
Group 2: mean: 71.0 bpm; standard deviation: 4.0 bpm
Group 3: mean: 70.4 bpm; standard deviation: 5.7 bpm
Group 4: mean: 76.9 bpm; standard deviation: 1.9 bpm
Group 3 has the lowest mean pulse rate. Group 4 has the most consistent pulse rate.

6. **a)** Diko **b)** Nazra

7. **a)** mean: 10.5 TDs; standard deviation: 5.6 TDs

b) e.g., He probably played fewer games in his rookie year (his first year) and his last year.

c) mean: 11.7 TDs; standard deviation: 5.2 TDs

d) The mean is higher and the standard deviation is lower.

8. **a)** mean: 1082 yards gained; standard deviation: 428.8 yards gained

b) Allen Pitts

9. **a)** Fitness Express: mean: 18.3 h; standard deviation: 4.9 h
Fit For Life: mean: 19.1 h; standard deviation: 5.3 h

b) Fitness Express

10. Jaime's mean travel time is about 21.2 minutes and her standard deviation is 3.5 minutes. Since her mean time is more than 20 minutes, Jaime will lose her job.

11. yes; mean: 45.0 calls; standard deviation: 7.1 calls

12. **a)**

	Games Played	Goals	Assists	Points
Mean	57.5	12.5	16.1	28.6
Standard Deviation	11.4	11.6	13.1	24.5

b) e.g., The standard deviation should decrease for games played and should increase for goals, assists, and points.

c)

	Games Played	Goals	Assists	Points
Mean	60.1	13.4	17.2	30.7
Standard Deviation	8.7	11.8	13.3	24.9

d) e.g., The means and standard deviations increased and decreased as I predicted.

e) e.g., The statement is true for data, and for means because we can add fractions with the same denominator together. However, standard deviations cannot be added because of how they are calculated.

13. e.g., One twin is more consistent, while the other is less consistent, resulting in the same mean (85.0%) with different standard deviations (2.6%, 12.0%).
Jane's scores: 80%, 85%, 82%, 87%, 86%, 84%, 87%, 85%, 85%, 89%
Jordana's scores: 78%, 92%, 99%, 64%, 72%, 82%, 77%, 95%, 98%, 93%

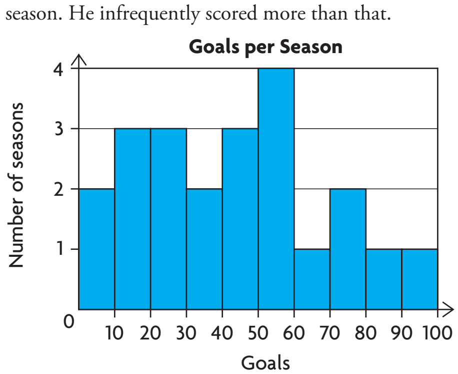
14. **a)** group A: mean: 8.57 s; standard deviation: 7.99 s
group B: mean: 5.55 s; standard deviation: 4.73 s

b) yes; group B (the group given visual information)

Mid-Chapter Review, page 267

1. Paris: 15.6 °C; Sydney: 17.8 °C

2. e.g., Wayne Gretzky tended to score between 0 and 60 goals per season. He infrequently scored more than that.



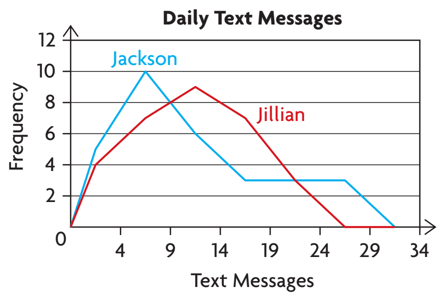
3. e.g.,

a) 5

b)

Text Messages	Jackson	Jillian
0–4	5	4
5–9	10	7
10–14	6	9
15–19	3	7
20–24	3	3
25–29	3	0

c)



4. Jackson: mean: 11.6 messages; standard deviation: 7.4 messages
Jillian: mean: 11.7 messages; standard deviation: 6.0 messages
e.g., Jillian and Jackson send about the same number of text messages, but Jillian is more consistent with her daily amount.

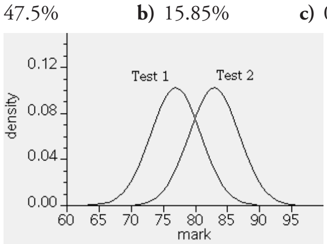
5. a) range: \$42.00; mean: \$21.95; standard deviation: \$8.24
b) range: \$15.00; mean: \$21.35; standard deviation: \$4.54
c) Removing the greatest and least amounts reduces the standard deviation.

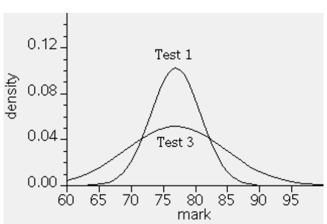
6. females: mean: \$27 391.30; standard deviation: \$7241.12
males: mean: \$41 614.79; standard deviation: \$19 542.92
e.g., Males tend to have larger salaries, but their salaries are less consistently close to the mean, suggesting a greater range.

Lesson 5.4, page 279

1. a) 47.5% b) 15.85% c) 0.15%

2. a)



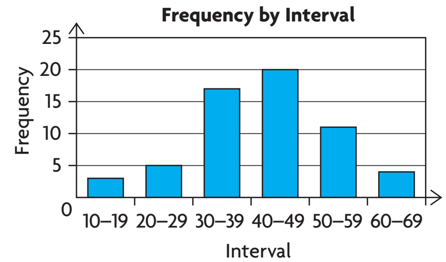


b) e.g., Test 1 and test 2 have different means, but the same standard deviation. Test 1 and test 3 have the same mean, but different standard deviations.

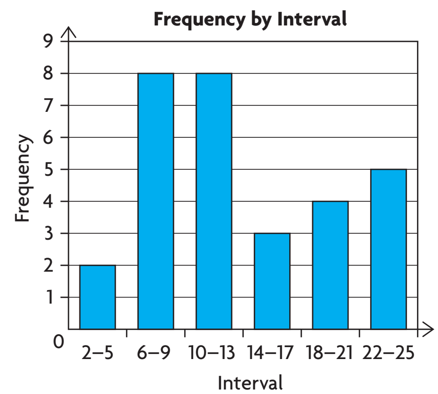
c) test 1: 84.8%; test 2: 79.1%; test 3: 99.2%

3. e.g.,

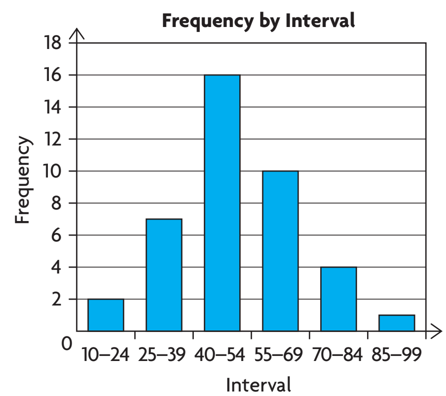
a) Yes. A graph of the data has a rough bell shape.



b) No. A graph of the data does not have a bell shape.



c) Yes. A graph of the data has a rough bell shape.



4. a) mean: 104.5 min; standard deviation: 22.3 min

b) e.g.,

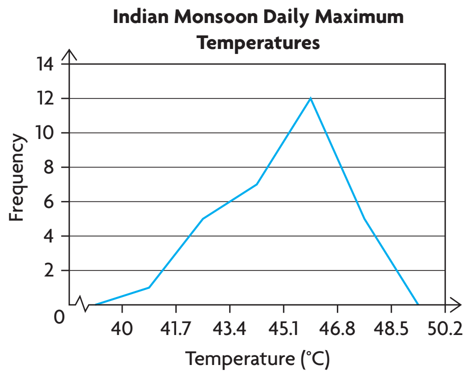
Movie Length (min)	Frequency
59.5–82.0	3
82.0–104.5	33
104.5–127.0	7
127.0–149.5	3
149.5–172.0	3
172.0–194.5	1

Answers

c) e.g., No. 80% of the data is within 1 standard deviation of the mean.

5. a) i) mean: 45.2 °C; median: 45.5 °C; standard deviation: 1.7 °C

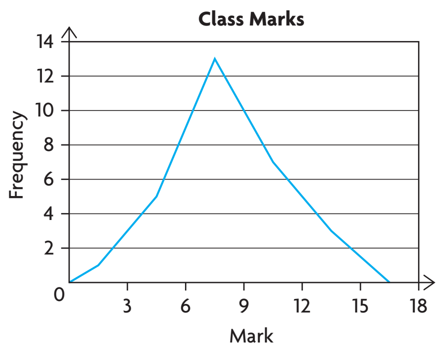
ii) e.g.,



iii) e.g., The median is close to the mean, but the frequency polygon is not symmetric around the mean, so the data is not normally distributed.

b) i) mean: 8.6; median: 8; standard deviation: 2.8

ii) e.g.,

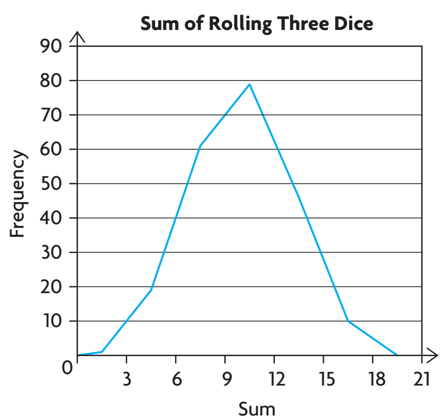


iii) e.g., The shape of the graph is roughly symmetrical with one peak in the middle tapering off to either side. The mean and median are fairly close to each other. The distribution is approximately normal.

6. about 3 years

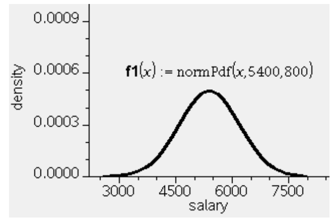
7. a) mean: 10.5; standard deviation: 4.6

b) e.g.,

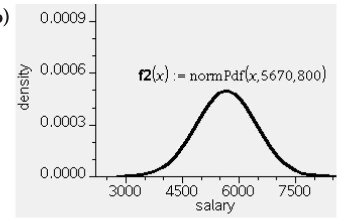


c) e.g., Yes, when you determine the percent of data in the various sections of the graph, they match the percent of data in a normal distribution.

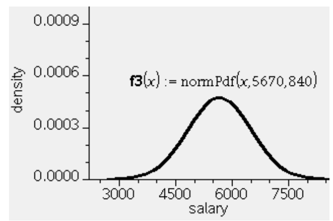
8. a)



b)



c)



9. e.g.,

a) Yes, when I determine the percent of the data within 1, 2, 3, and 4 standard deviations of the mean, they agree with the percents for a normal distribution.

b) The mean is 72.25, the median is 72, and the mode 73. The values are close together, so the golf scores appear to be normally distributed.

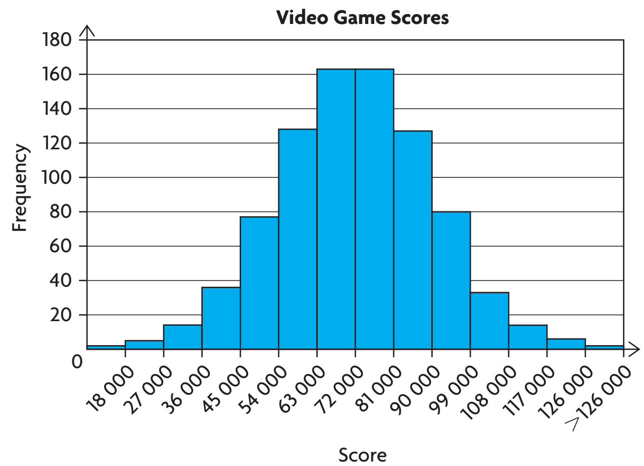
10. 2.3%, or about 3 dolphins

11. a) 44.6 kg–99.0 kg

b) 31.0 kg–112.6 kg

c) e.g., Julie assumed that the masses of North American men and women is normally distributed about the mean. However, men and women have different mean masses.

12. a) Yes



b) Yes; mean: 72 010 points; standard deviation: 18 394 points. The percent of scores within 1, 2, and 3 standard deviations are very close to the expected values for a normal distribution:
$\mu \pm 1\sigma = 68.35\%$
$\mu \pm 2\sigma = 94.94\%$
$\mu \pm 3\sigma = 99.53\%$

13. a) 68%, or about 41 dogs c) 99.7%, or about 60 dogs
b) 95%, or about 57 dogs d) 50%, or about 30 dogs

14. mean: 482 kg; standard deviation: 17 kg

15. e.g., The 10 students could all have the highest marks in the class, so they would not be normally distributed.

16. e.g., No. The male dog would have been over 10 standard deviations heavier than average, and the female dog would have been over 13 standard deviations lighter than average. These masses are improbable.

Lesson 5.5, page 292

1. a) 4 c) −1.92
b) −0.75 d) 2.455…
2. a) 89.25% c) 98.50%
b) 0.94% d) 26.11%
3. a) 6.88% b) 75.18%
4. a) −1.28 c) 0.25
b) 1.28 d) −0.25
5. a) 1.892… c) 0.505…
b) −2.6875 d) 1.666…
6. a) 71.23% c) 0.14%
b) 3.92% d) 99.16%
7. a) 91.15% c) 24.83%
b) 0.43% d) 99.92%
8. a) 39.95% b) 89.90%
9. a) −0.439… b) 0.841…
10. a) English: 2.352… Math: 3.148…
b) Math
c) e.g., the job market, her preferences, whether absolute or relative marks are more important for university applications
11. 92.70%
12. water walking
13. a) 90.60% or 91.24%, depending on method used
b) 3.11% or 3.14%, depending on method used

c) 0.88%; e.g., Someone might want to see if the percentage of high-school age mothers with young children is decreasing or increasing. Someone might use this data to justify funding for social programs targeting this group.

14. mean: 180 cm; standard deviation: 15.6 cm
15. a) 0.38% b) 37.81% c) 5.29%
16. a) about 2 b) 10.56%
17. 50 months, or round down to 4 years
18. 76%
19. e.g., For the high-priced car, the *z*-score is 0.5, which means that about 69% of the repairs will be less than \$3000; thus, 31% of the repairs will be more than \$3000. For the mid-priced car, the *z*-score is 1.25, which means that about 89% of the repairs will be less than \$3000; thus, 11% of the repairs will be more than \$3000.
20. a) 131 b) 140 c) 108
21. A *z*-score is a value that indicates the number of standard deviations of a data value above or below the mean. It is calculated by subtracting the mean from the data value, and then dividing by the standard deviation. Knowing the *z*-score of two or more pieces of data in different data sets allows you to compare them, which is useful for making decisions.
22. a) 5.02 kg
b) 63.4%; e.g., No; too many bags will have more than 5 kg of sugar.
23. a) mean: 150; standard deviation: 9.61
b) 1.1%
24. e.g., If the ABC Company wants its process to meet 6-Sigma standards, that is, to reject fewer than 1 bungee cord per 300 produced, what standard deviation does the company need to have in its manufacturing process? Answer: The ABC Company needs to reduce its standard deviation to 1.0 cm if it wants to reject only 0.33% of bungee cords.

Lesson 5.6, page 302

1. a) 95%
b) 77.9%–84.1%
c) 26.1 million to 28.2 million
2. a) 540.1 g to 543.9 g
b) 50: 3.9 g; 100: 2.7 g; 500: 1.2 g
3. a) 90%
b) 60.6%–67.4%
c) about 19–22 students
4. a) With 95% confidence, it can be said that 78.8% to 83.2% of Canadians support bilingualism in Canada and that they want Canada to remain a bilingual country.
b) e.g., I disagree with Mark. Without having more information about how the poll was conducted, it is impossible to tell if the poll was flawed.
5. a) 54.9%–61.1%
b) e.g., Swift Current, Saskatchewan, has a population of 16 000 residents. Between 8784 and 9776 people would have answered the question correctly.
6. a) 99%; 84.7% to 93.3%
b) 19 904 500 to 21 925 500
7. e.g.,
a) The Canadian Press Harris-Decima surveyed Canadians in early 2010 to find out how people felt about the proposed rewording of "O Canada." The poll found that 74% of Canadians opposed the rewording, with a margin of error of 2.2 percentage points, 19 times out of 20.
b) 71.8%–76.2%

c) With such a high percent of Canadians polled opposing the rewording, and the relatively tight confidence interval, I agree with the conclusion of the poll.

8. a) confidence interval: 174.8 g to 175.2 g
margin of error: $\pm$ 0.2 g
b) 135
c) 55
d) 78

9. a) With 90% confidence, it can be said that 49.5% to 58.5% of post-secondary graduates can be expected to earn at least $100 000/year by the time they retire.
b) With 99% confidence, it can be said that 60.9% to 65.1% of online shoppers search for coupons or deals when shopping on the Internet.
c) With 95% confidence, it can be said that Canadians spend an average of 17.5 h to 18.7 h online, compared to 16.3 h to 17.5 h watching television per week.
d) With 95% confidence, it can be said that 36% to 42% of decided voters will not vote for the political party in the next election.

10. a) As the sample size increases, the denominator in the formula for margin for error increases, so the margin of error decreases.
b) As the confidence level increases, the *z*-score in the formula for margin for error increases, so the margin of error increases.

11. a)

Sample Size	Pattern	Margin of Error
100		9.80%
400	$\sqrt{\frac{100}{400}} = \frac{1}{2}$	$9.80\% \cdot \frac{1}{2} = 4.90\%$
900	$\sqrt{\frac{400}{900}} = \frac{2}{3}$	$4.90\% \cdot \frac{2}{3} = 3.27\%$
1600	$\sqrt{\frac{900}{1600}} = \frac{3}{4}$	$3.27\% \cdot \frac{3}{4} = 2.45\%$
2500	$\sqrt{\frac{1600}{2500}} = \frac{4}{5}$	$2.45\% \cdot \frac{4}{5} = 1.96\%$
3600	$\sqrt{\frac{2500}{3600}} = \frac{5}{6}$	$1.96\% \cdot \frac{5}{6} = 1.63\%$

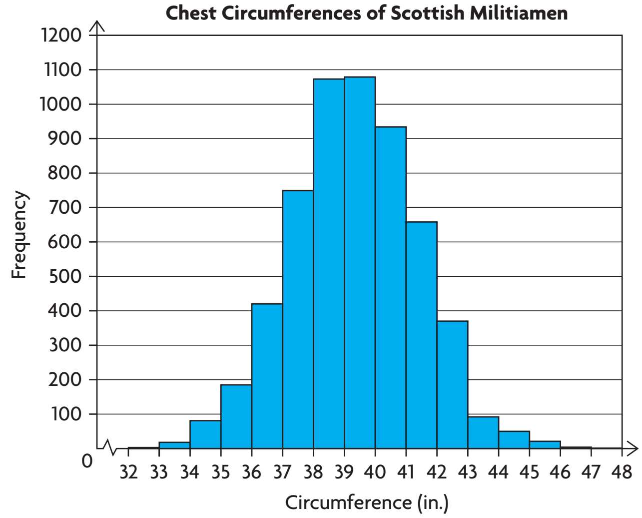
b) i) 1.40% ii) 2.19%
c) e.g., The margin of error gets smaller at a much faster rate than the sample size grows. Therefore, a relatively small sample is needed to get a small margin of error.

12. a) $27.06 \cdot 10^7$ m/s
b) $5.05 \cdot 10^7$ m/s
c) $1.26 \cdot 10^7$ m/s
d) $25.80 \cdot 10^7$ m/s to $28.32 \cdot 10^7$ m/s
e) e.g., Simon Newcomb's estimates are too low to include the modern accepted value.

Chapter Self-Test, page 305

1. a) 1999: mean: 43.4 in.; standard deviation: 3.0 in.
2011: mean: 67.8 in.; standard deviation: 5.6 in.
b) The heights for 2011 have a greater standard deviation. Children are much closer in height than teenagers, which is why there is greater deviation in the teenagers' heights.

2. a) e.g., The graph of the data shows a normal distribution.



b) 1.06 in.

3. e.g., Edmonton's temperature is lower on average, but less consistently close to the mean.

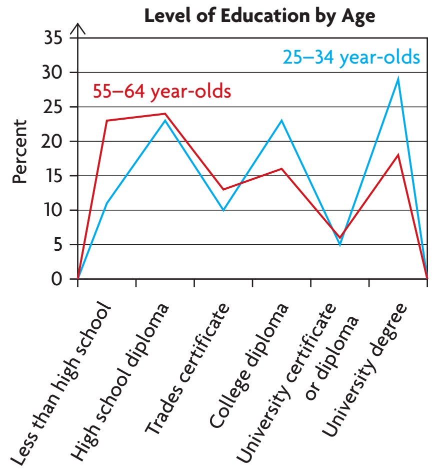
4. a) If the poll was conducted with a random sample of 1009 Canadians 100 times, you can be confident that 95 times the results would be that
- 84.9% to 91.1% of people would say that the flag makes them proud of Canada
- 76.9% to 83.1% of people would say that hockey makes them proud of Canada
- 30.9% to 47.1% of people would say that our justice system makes them proud of Canada

b) 26 160 611 to 28 269 789 people
c) The margin of error would increase since the confidence level that would be used in the new poll increased to 99% from 95%.

Chapter Review, page 308

1. Twila: mean: 46.5 min; range: 25 min
Amber: mean: 45.5 min; range 75 min
e.g., Each girl spent about the same amount of time on homework every day, but Amber spends a greater range of times on homework than Twila.

2. e.g., More people aged 25 to 34 years old have higher levels of education.



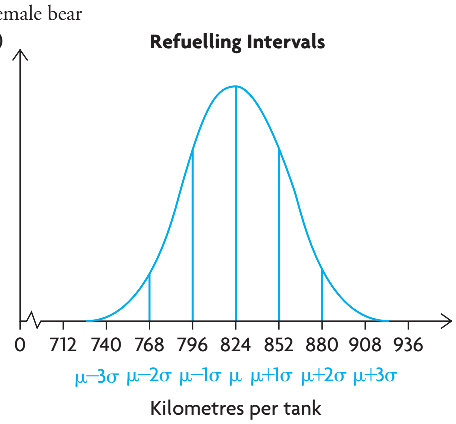
3. a) e.g., Twila's data will have the lowest standard deviation. The numbers are closer to the mean.
   b) Twila: 7.8 min; Amber: 26.9 min; yes

4. a)

Level of Education	Mean ($1000)	Standard Deviation ($1000)
No Diploma	18.8	2.6
High School	23.8	4.1
Post-Secondary	36.8	5.5

   b) post-secondary
   c) post-secondary

5. bag of sunflower seeds
6. female bear
7. a)

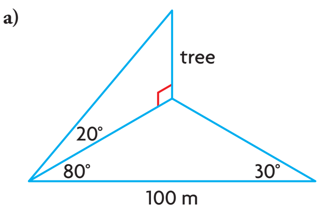


   b) 68%
   c) 16%
   d) 769 km and 879 km

8. a) mean: 36.9 °C; standard deviation: 0.4 °C
   b) e.g., Yes. About 69% of the data is within one standard deviation of the mean, about 94% of the data is within two standard deviations of the mean, and about 99% of the data is within three standard deviations of the mean, which is close to the percents expected for a normal distribution.
9. 10.6%
10. Computers For All
11. a) Internet: 60.5% to 63.3%
    Friends/family: 67.5% to 70.3%
    Health line: 16.5% to 19.3%
    b) Internet: 208 725 to 218 385 people
    Friends/family: 232 875 to 242 535 people
    Health line: 56 925 to 66 585 people
12. a) The margin of error of company A is smaller than the margin of error of company B.
    b) Company A's sample was larger than company B's sample.

Cumulative Review, page 315

1. a) $x = 12.6$ cm b) $p = 7.6$ m
2. a) 40° b) 43°
3. $d = 12.2$ cm, $\angle E = 44.2°$, $\angle F = 77.7°$
4. 3.5 km, N39.0°W
5. 92.9 m, 80.7 m
6. 48.2°, 73.4°, 58.4°
7. a)



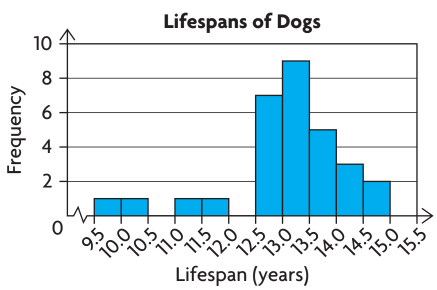
   b) 19.4 m
8. a) i) $-\sqrt{320}$ ii) $\sqrt{12x^5y^3}$
   b) $x \geq 0, x \in \mathrm{R}$
9. a) $18\sqrt{2}$ c) $-3\sqrt{2}$
   b) $43 + \sqrt{2}$ d) $\dfrac{1 - \sqrt{2}}{2}$
10. a) $7a\sqrt{3}$ c) $a \geq 0, a \in \mathrm{R}$; $12\sqrt{a} - 15a$
    b) $x \geq 0, x \in \mathrm{R}$; $3x - 2x^2$ d) $x \geq 0, x \in \mathrm{R}$; $32x - 12\sqrt{2x} + 9$
11. a) 13 b) 36
12. 256 ft

Answers

13. e.g.,

a)

Lifespan (years)	Frequency
9.5–10.0	1
10.0–10.5	1
10.5–11.0	0
11.0–11.5	1
11.5–12.0	1
12.0–12.5	0
12.5–13.0	7
13.0–13.5	9
13.5–14.0	5
14.0–14.5	3
14.5–15.0	2



b) No

c) range: 5.2 years; standard deviation: 1.12 years. e.g., The data does not deviate very much from the mean.

14. e.g., Winnipeg and Whitehorse have approximately the same temperature in January, but the temperature varies more in Whitehorse.

15. **a)** 92.3% **b)** 7.7%

16. **a)** 2.3% **b)** 15.7%

17. **a)** margin of error: 3.1%, confidence level: 95%
b) i) 20.0%–26.2% **ii)** 9.5%–15.7%

18. e.g.,
a) The confidence level decreases as the margin of error decreases because we can be less certain that the true mean is in the range specified.
b) The confidence level decreases as the sample size decreases because the *z*-score must decrease to keep the margin of error constant.

Chapter 6

Lesson 6.1, page 324

1. **a)** not a quadratic relation **b)** not a quadratic relation **c)** not a quadratic relation **d)** quadratic relation **e)** quadratic relation **f)** not a quadratic relation
2. **a)** not a quadratic relation **b)** quadratic relation **c)** quadratic relation **d)** quadratic relation **e)** not a quadratic relation **f)** not a quadratic relation
3. **b)** 0 **c)** 17 **d)** -6
4. e.g., If $a = 0$, then $y = bx + c$, which is a linear relation, not a quadratic relation.
5. **a)** up, $a > 0$ **b)** down, $a < 0$ **c)** up, $a > 0$ **d)** down, $a < 0$
6. **a)** up **b)** down **c)** up **d)** down

Lesson 6.2, page 332

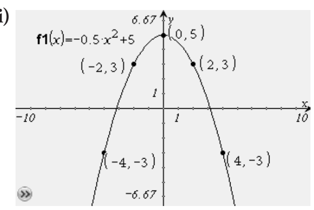
1. **a)** $x = 4$ **b)** $(4, -16)$ **c)** $\{(x, y) \mid x \in R, y \geq -16, y \in R\}$
2. **a)** (0, 8); e.g., (1, 18), $(-1, 2)$ **b)** (0, 0); e.g., (1, 3), $(-1, -5)$
3. **a)** (0, 0), (2, 0); (0, 0); $x = 1$; $(1, -2)$; $\{(x, y) \mid x \in R, y \geq -2, y \in R\}$
   b) $(-1, 0)$, (6, 0); (0, 4.5); $x = 2.5$; (2.5, 9.1); $\{(x, y) \mid x \in R, y \leq 9.1, y \in R\}$
4. **a)** $x = 2$; $(2, -1)$; $\{(x, y) \mid x \in R, y \geq -1, y \in R\}$
   b) $x = 4$; (4, 28); $\{(x, y) \mid x \in R, y \leq 28, y \in R\}$
   c) $x = 3$; $(3, -1)$; $\{(x, y) \mid x \in R, y \leq -1, y \in R\}$
   d) $x = 2.5$; $(2.5, -12.25)$; $\{(x, y) \mid x \in R, y \geq -12.25, y \in R\}$
5. **a)** graph d; $(2.5, -12.25)$ **b)** graph b; (4, 28) **c)** graph c; $(3, -1)$ **d)** graph a; $(2, -1)$
6. **a)** maximum of 4 **b)** minimum of -3 **c)** maximum of 2
7. **a) i)**

x	−4	−2	0	2	4
y	−3	3	5	3	−3

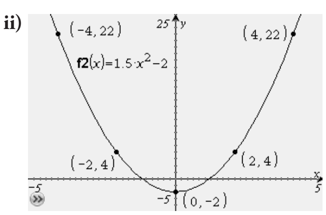
ii)

x	−4	−2	0	2	4
y	22	4	−2	4	22

b) i)

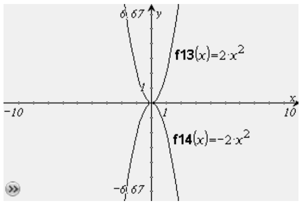


ii)



c) i) $\{(x, y) \mid x \in R, y \leq 5, y \in R\}$
ii) $\{(x, y) \mid x \in R, y \geq -2, y \in R\}$

8. **a)**



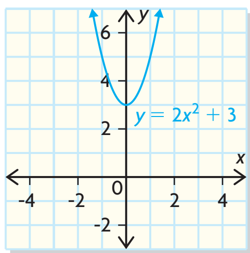
b) e.g., same vertex, axis of symmetry, and shape. One opens up, the other opens down.

c) e.g., vertex for both is (0, 4), original vertex moves up 4 units for each

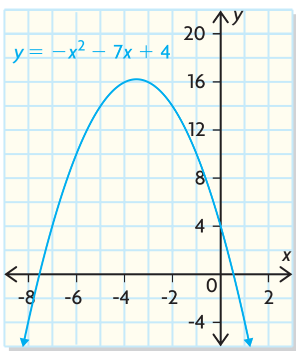
9. **a)** $x = 3$ **c)** $x = -2$
b) $x = 5$ **d)** $x = -1$

10. $x = -6$

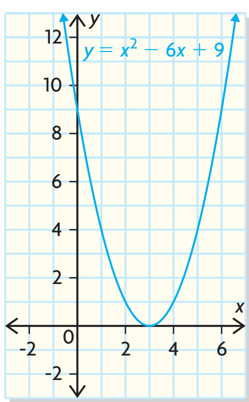
11. **a)** **i)**



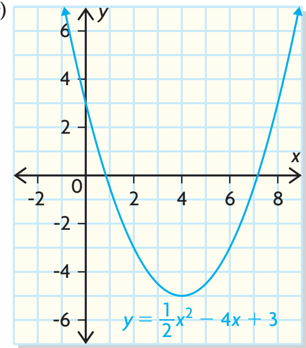
ii)



iii)



iv)



b) **i)** $x = 0$; (0, 3) **iii)** $x = 3$; (3, 0)
ii) $x = -3.5$; (−3.5, 16.25) **iv)** $x = 4$; (4, −5)

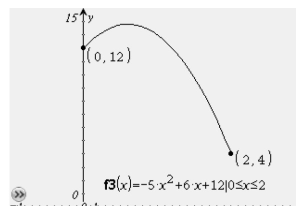
c) **i)** $\{(x, y) \mid x \in R, y \geq 3, y \in R\}$
ii) $\{(x, y) \mid x \in R, y \leq 16.25, y \in R\}$
iii) $\{(x, y) \mid x \in R, y \geq 0, y \in R\}$
iv) $\{(x, y) \mid x \in R, y \geq -5, y \in R\}$

12. 1.56 seconds

13. **a)** 31.9 m
b) $\{(x, y) \mid x \leq 5.1, x \in R, 0 \leq y \leq 31.9, y \in R\}$
c) 5.1 seconds

14. $\{(t, h) \mid 0 \leq t \leq 16.3, t \in R, 0 \leq h \leq 326.5, h \in R\}$

15. $\{(x, f(x)) \mid 0 \leq x \leq 2, x \in R, 4 \leq f(x) \leq 13.8, f(x) \in R\}$



16. **a)** minimum since $a > 0$
b) Method 1: Determine the equation of the axis of symmetry.

$$x = \frac{-1 + 5}{2}$$
$$x = 2$$

Determine the y-coordinate of the vertex.

$$y = 4(2)^2 - 16(2) + 21$$
$$y = 16 - 32 + 21$$
$$y = 5$$

The minimum value is (2, 5).

Method 2: Create a table of values.

x	−2	−1	0	1	2	3
y	69	41	21	9	5	9

The vertex is halfway between (1, 9) and (3, 9), which have the same y-value, so the vertex is (2, 5).

17. **a)** The y-coordinates are equal.
b) e.g., Substitute the x-coordinate from the axis of symmetry into the quadratic equation.

18. e.g., Yes, Gamez Inc.'s profit increased, unless the number of games sold was 900 000; then the profit is the same. For all points except $x = 9$, the second profit function yields a greater profit.

19. $y = -\frac{1}{2}x^2 - 3x + 10$

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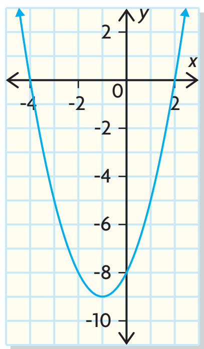
1. **a)** iii **d)** vi
b) ii **e)** iv
c) v **f)** i

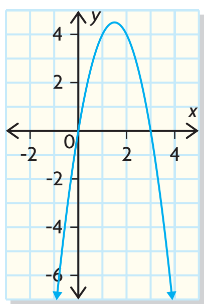
2. **a)** **i)** $x = -4, x = 2$ **ii)** $y = -8$ **iii)** $x = -1$ **iv)** $(-1, -9)$

v) $y = (x + 4)(x - 2)$



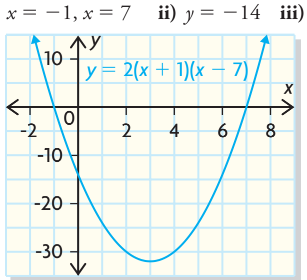
b) **i)** $x = 0, x = 3$ **ii)** $y = 0$ **iii)** $x = 1.5$ **iv)** $(1.5, 4.5)$

v) $y = -2x(x - 3)$



c) **i)** $x = -1, x = 7$ **ii)** $y = -14$ **iii)** $x = 3$ **iv)** $(3, -32)$

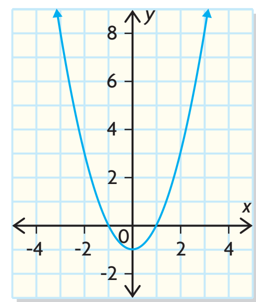
v)



3. $y = (x + 2)(x - 4)$

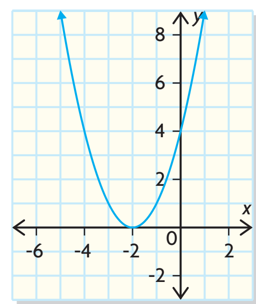
4. **a)** x-intercepts: $-1, 1$; y-intercept: -1; vertex: $(0, -1)$
equation of the axis of symmetry: $x = 0$
b) x-intercept: -2; y-intercept: 4; vertex: $(-2, 0)$
equation of the axis of symmetry: $x = -2$
c) x-intercept: 3; y-intercept: 9; vertex: $(3, 0)$
equation of the axis of symmetry: $x = 3$
d) x-intercepts: $-1, 2$; y-intercept: 4; vertex: $(0.5, 4.5)$
equation of the axis of symmetry: $x = 0.5$
e) x-intercept: 2; y-intercept: 12; vertex: $(2, 0)$
equation of the axis of symmetry: $x = 2$
f) x-intercept: 1; y-intercept: 4; vertex: $(1, 0)$
equation of the axis of symmetry: $x = 1$

5. **a)** $y = (x - 1)(x + 1)$



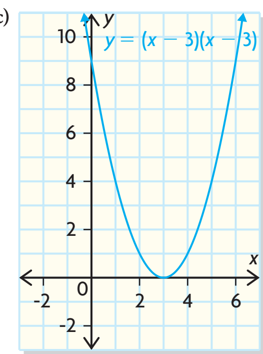
$\{(x, y) \mid x \in \mathrm{R}, y \geq -1, y \in \mathrm{R}\}$

b) $y = (x + 2)(x + 2)$



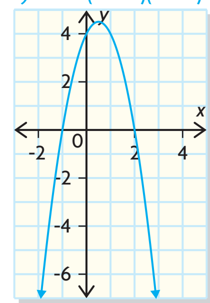
$\{(x, y) \mid x \in \mathrm{R}, y \geq 0, y \in \mathrm{R}\}$

c)



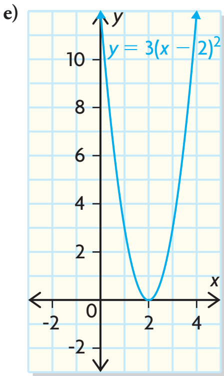
$\{(x, y) \mid x \in \mathrm{R}, y \geq 0, y \in \mathrm{R}\}$

d) $y = -2(x - 2)(x + 1)$



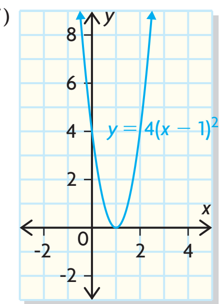
$\{(x, y) \mid x \in \mathrm{R}, y \leq 4.5, y \in \mathrm{R}\}$

e)



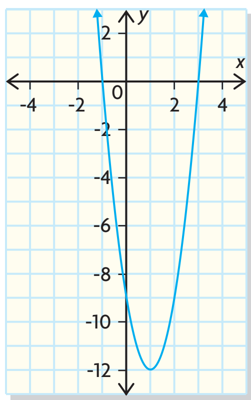
$\{(x, y) \mid x \in \mathrm{R}, y \geq 0, y \in \mathrm{R}\}$

f)



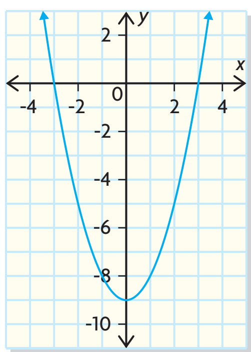
$\{(x, y) \mid x \in \mathrm{R}, y \geq 0, y \in \mathrm{R}\}$

6. $y = 3(x - 3)(x + 1)$



e.g., If $a = 1$ or $a = 2$, the graph would be stretched vertically. If $a = 0$, the graph would be linear. If $a = -1$ or $a = -2$, the graph would be stretched vertically and reflected in the x–axis. If $a = -3$, the graph would be reflected in the x–axis.

7. $y = (x - 3)(x + 3)$

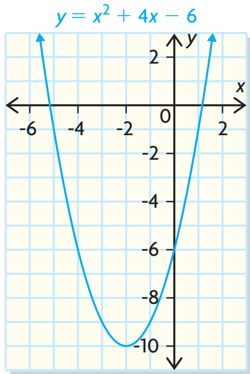


e.g.,
If $s = 2$, zeros at $x = 3$ and $x = -2$, the vertex moves to $(0.5, -6.25)$.
If $s = 1$, zeros at $x = 3$ and $x = -1$, the vertex moves to $(1, -4)$.
If $s = 0$, zeros at $x = 3$ and $x = 0$, the vertex moves to $(1.5, -2.25)$.
If $s = -1$, zeros at $x = 3$ and $x = 1$, the vertex moves to $(2, -1)$.
If $s = -2$, zeros at $x = 3$ and $x = 2$, the vertex moves to $(2.5, -0.25)$.
If $s = -3.8$, zeros at $x = 3$ and $x = 3.8$, the vertex moves to $(3.4, -0.16)$.

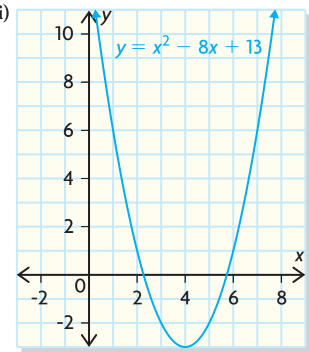
8. **a)** 312.5 m^2 **b)** $\{(x, y) \mid 0 \le x \le 25, x \in R, 0 \le y \le 312.5, y \in R\}$

9. \$12, \$720

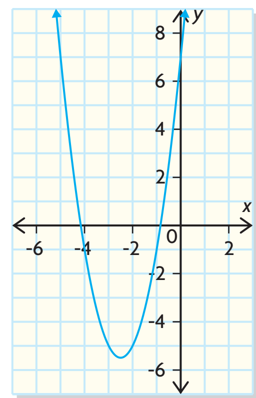
10. **a) i)** e.g., $(0, -6), (-4, -6)$ **ii)** $(-2, -10)$
iii) $y = x^2 + 4x - 6$



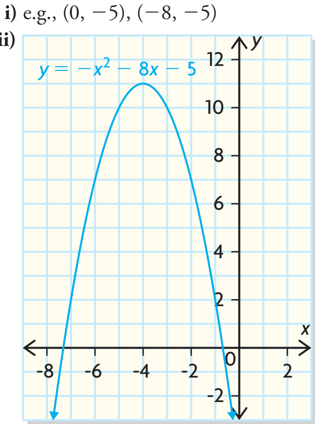
b) i) e.g., $(0, 13), (8, 13)$ **ii)** $(4, -3)$
iii)



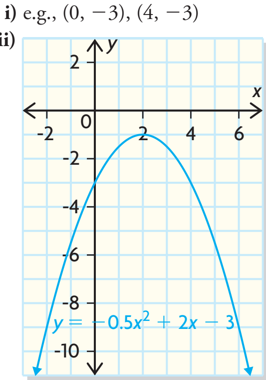
c) i) e.g., $(-5, 7), (0, 7)$ **ii)** $(-2.5, -5.5)$
iii) $y = 2x^2 + 10x + 7$



d) i) e.g., $(0, -5), (-8, -5)$ **ii)** $(-4, 11)$
iii)

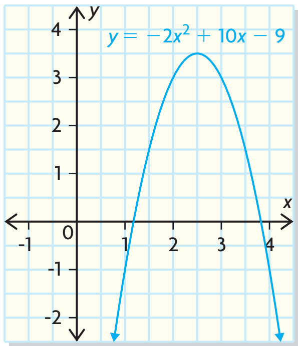


e) i) e.g., $(0, -3), (4, -3)$ **ii)** $(2, -1)$
iii)



f) i) e.g., $(0, -9)$, $(5, -9)$ **ii)** $(2.5, 3.5)$

iii)



11. **a)** $y = \frac{1}{2}x^2 - 2x - 6$ **b)** $y = x^2 - 5x + 4$ **c)** $y = -\frac{1}{4}x^2 - x + 3$ **d)** $y = -x^2 + 6x$

12. **a)** e.g., Method 1: Use partial factoring.

$f(x) = -2x^2 + 16x - 24$

$f(x) = -2x(x - 8) - 24$

$-2x = 0$ $\quad$ $x - 8 = 0$

$x = 0$ $\quad$ $x = 8$

$f(0) = -24$ $\quad$ $f(8) = -24$

The points $(0, -24)$ and $(8, -24)$ are the same distance from the axis of symmetry.

$x = \frac{0 + 8}{2}$

$x = 4$

The equation of the axis of symmetry is $x = 4$.

$f(4) = -2(4)^2 + 16(4) - 24$

$f(4) = 8$

The vertex is $(4, 8)$.

Method 2: Factor the equation to determine the x-intercepts.

$f(x) = -2x^2 + 16x - 24$

$f(x) = -2(x^2 - 8x + 12)$

$f(x) = -2(x - 6)(x - 2)$

$x - 6 = 0$ $\quad$ $x - 2 = 0$

$x = 6$ $\quad$ $x = 2$

The x-intercepts are $x = 2$ and $x = 6$.

$x = \frac{2 + 6}{2}$

$x = 4$

The equation of the axis of symmetry is $x = 4$.

$f(4) = -2(4)^2 + 16(4) - 24$

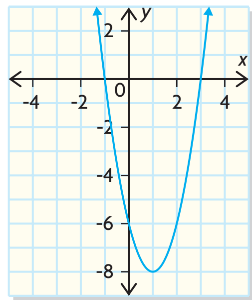
$f(4) = 8$

The vertex is $(4, 8)$.

b) e.g., I prefer putting the equation into vertex form because it takes fewer steps.

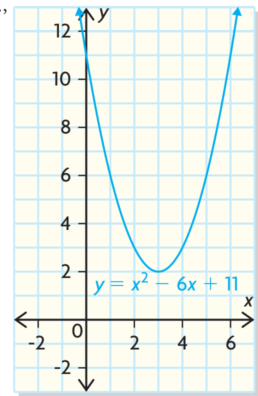
13. $y = 2x^2 - 4x - 6$

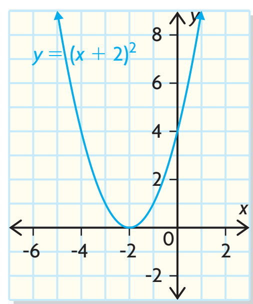
$y = 2x^2 - 4x - 6$



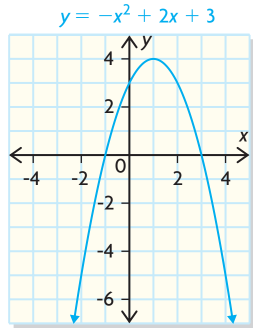
14. A quadratic function can have no zeros, one zero, or two zeros.

e.g.,





$y = -x^2 + 2x + 3$



15. **a)** $\{(x, y) \mid 0 \le x \le 4, x \in R, -1 \le y \le 0, y \in R\}$ **b)** $y = \frac{1}{4}x^2 - x$

16. 12.5 feet by 25 feet

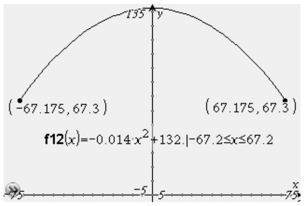
17. **a)** $h = -5.5t^2 + 33t$

b) $\{(t, h \mid 0 \le t \le 6, t \in R, 0 \le h \le 49.5, h \in R\}$

18. e.g., The x-intercepts are $x = -3$ and $x = 1$. Therefore, $y = a(x - 1)(x + 3)$. Substitute a point on the graph, say (3, 6), into the equation to obtain $a = \frac{1}{2}$.

19. a) $y = -0.077x^2 + 33$
b) $\{(x, y) \mid -20.702 \le x \le 20.702, x \in R, 0 \le y \le 33, y \in R\}$
c) $(-4.2, 0), (-37.3, 0)$

20. a) $y = -0.0144x^2 + 132.279$
b) $\{(x, y) \mid -67.175 \le x \le 67.175, x \in R, 0 \le y \le 132.279, y \in R\}$
The grass closest to first and third base is the largest distance to the left or right. The grass closest to second base is the largest vertical distance.
c)



21. 50 feet by 94 feet

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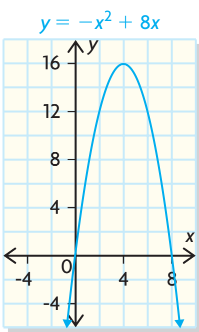
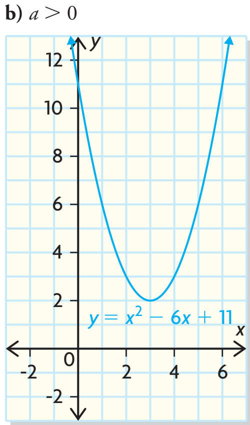
1. a) no c) yes
b) yes d) no

2. a) $y = 0$
b)

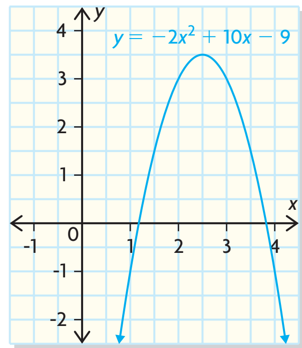


c) $x = 4$; (4, 16); $x = 0, x = 8$; $\{(x, y) \mid x \in R, y \le 16, y \in R\}$

3. a) e.g., If $a > 0$, then the parabola opens up; if $a < 0$, then the parabola opens down.
b) $a > 0$



$a < 0$



4. a) iv c) i
b) iii d) ii

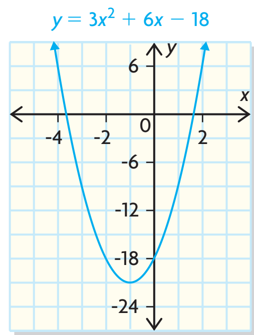
5. a) $t = 0, t = 24$
b) 12 seconds, 720 metres
c) 675 metres
d) $\{(t, h) \mid 0 \le t \le 24, t \in R, 0 \le h \le 720, h \in R\}$

6. $x = -1$

7. $y = \frac{1}{4}x^2 + \frac{1}{2}x - 2$

8. a) $y = \frac{1}{2}x^2 - 3x - 36$
b) $(3, -40.5)$
c) $\{(x, y) \mid x \in R, y \ge -40.5, y \in R\}$

9.



10. $26.25

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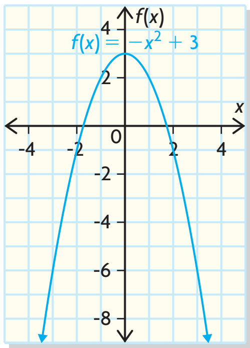
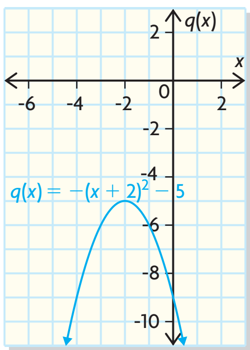
1. a) i) upward ii) (3, 7) iii) $x = 3$
b) i) downward ii) $(-7, -3)$ iii) $x = -7$
c) i) upward ii) $(2, -9)$ iii) $x = 2$
d) i) upward ii) $(-1, 10)$ iii) $x = -1$
e) i) downward ii) (0, 5) iii) $x = 0$

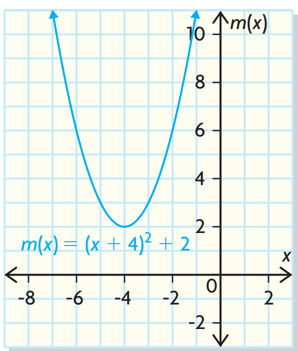
2. **a)** maximum, 2 x-intercepts



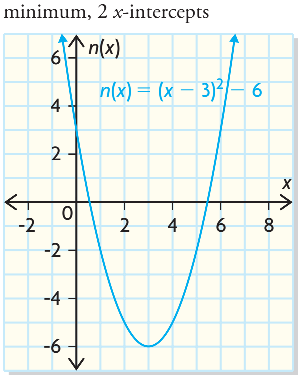
b) maximum, 0 x-intercepts



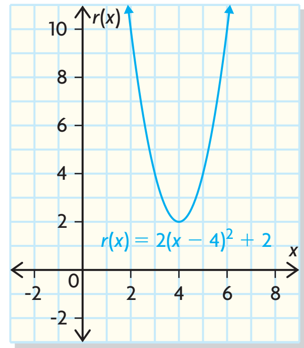
c) minimum, 0 x-intercepts



d) minimum, 2 x-intercepts



e) minimum, 0 x-intercepts

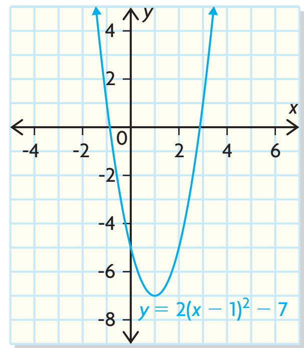


3. -3

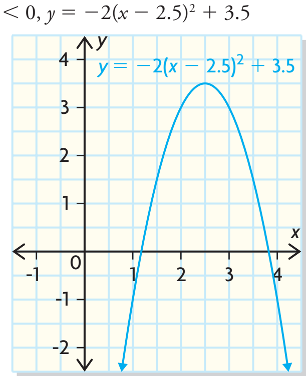
4. C. The vertex is (3, 5) and passes through the point (0, -1).

5. **a)** iv; The vertex is (3, 0).
b) iii; The vertex is (-4, -2).
c) i; The vertex is (0, -3).
d) ii; The vertex is (4, 2).

6. If $a > 0$, the parabola contains a minimum value. If $a < 0$, the parabola contains a maximum value.
$a > 0$, $y = 2(x - 1)^2 - 7$



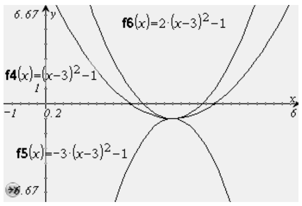
$a < 0$, $y = -2(x - 2.5)^2 + 3.5$



7. red, $y = (x + 4)^2$; $a = 1$
purple, $y = (x - 4)^2$; $a = 1$
blue, $y = -(x - 4)^2 - 4$; $a = -1$
orange, $y = x^2 + 4$; $a = 1$
green, $y = -x^2 - 4$; $a = -1$
The parabolas are congruent.

8. **a)** $x = 9$
b) 8 ft
c) 6.5 ft
d) $\{h(x) \mid 6.5 \leq h \leq 8, h \in \mathrm{R}\}$

9. **a)** e.g., $y = (x - 3)^2 - 1$, $y = 2(x - 3)^2 - 1$, $y = -3(x - 3)^2 - 1$
b) The second graph is narrower than the first graph, and the third graph opens downward instead of upward.

c) 

e.g., My predictions were accurate.

10. e.g., The vertex is $(1, -9)$, the graph opens upward, the equation of the axis of symmetry is $x = 1$, and the y-intercept is $(0, -7)$. I would draw a parabola that has all of these features.

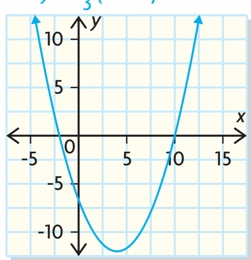
11. **a)** $y = -\frac{1}{4}x^2 + 36$ **b)** $y = -\frac{2}{9}(x - 3)^2 + 2$

12. **a)** $y = a(x - 4)^2 - 12, a \neq 0, a \in R$

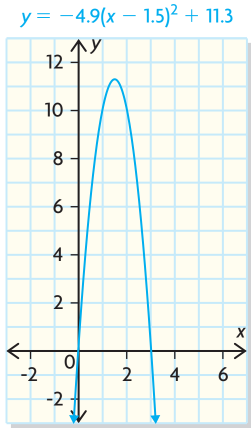
b) $y = \frac{1}{3}(x - 4)^2 - 12$

c) $\{(x, y) \mid x \in R, y \geq -12, y \in R\}$

d)



13. **a)** zeros: 0, 3



b) e.g., One zero represents the location of the sprinkler and the other zero represents where the water lands on the grass.

14. **a)** $y = -2.4(x + 3.5)^2 + 15$

b) $\{(x, y) \mid x \in R, y \leq 15, y \in R\}$

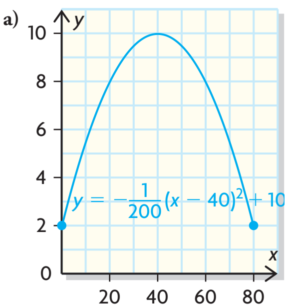
15. **a)** $y = 0.08(x - 2.5)^2 + 0.5$

b) 0.68 m

c) $\{(x, y) \mid 0 \leq x \leq 5, x \in R, 0.5 \leq y \leq 1, y \in R\}$

16. e.g., It is easier to graph the quadratic function when it is in vertex form because you can determine the vertex, the y-intercept, and direction of the graph without doing any calculations.

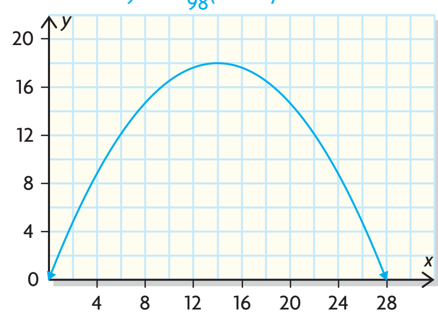
17. **a)**



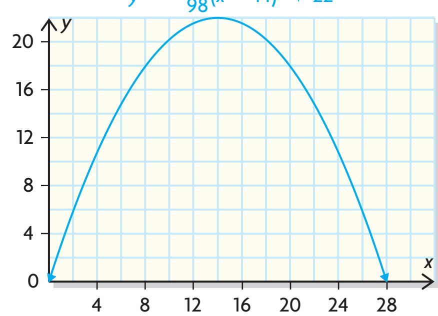
b) The atlatl dart was 20 yd from Peter as it rose in the air, then 60 yd as it came down.

18. **a)** $h(t) = 5(t - 10)^2 + 20$ **b)** 20 m **c)** 20 s

19. e.g., $-\frac{9}{98}(x - 14)^2 + 18$



e.g., $-\frac{11}{98}(x - 14)^2 + 22$



Lesson 6.5, page 376

1. **a)** $y = 3x^2 - 5$ **c)** $y = -3(x + 1)^2$

b) $y = -(x - 2)^2 + 3$ **d)** $y = 0.25(x + 1.2)^2 + 4.8$

2. $y = -\frac{3}{8}(x + 5)^2 + 2$

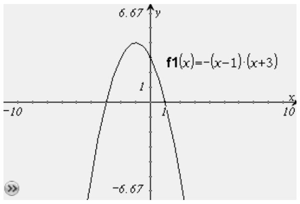
3. **a)** $y = 2x^2 + 3$ **c)** $y = -(x + 1)^2 + 4$

b) $y = \frac{1}{2}(x - 3)^2$ **d)** $y = -\frac{1}{2}(x - 2)^2 - 5$

4. $y = -(x - 5)^2 + 4$

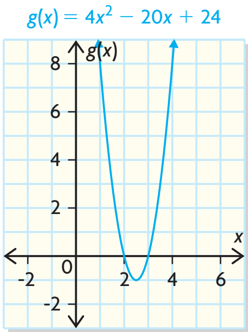
Answers

5. **a)** **i)**



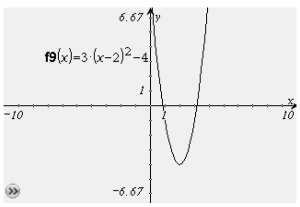
ii) maximum of 4 **iii)** $f(x) = -x^2 - 2x + 3$

b) **i)**



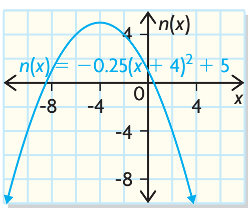
ii) minimum of -1 **iii)** $g(x) = 4x^2 - 20x + 24$

c) **i)**



ii) maximum of -4 **iii)** $m(x) = 3x^2 - 12x + 8$

d) **i)**



ii) maximum of 5 **iii)** $n(x) = -0.25x^2 - 2x + 1$

6. **a)** $y = -0.5x^2 + 4$
b) $y = 2(x - 4)^2 - 2$
c) $y = -(x - 4)^2 + 4$
d) $y = 0.8(x + 1)^2 - 3.2$

7. **a)** $h(t) = -5(t - 5)^2 + 1500$ **b)** 1500 m

8. **a)** $h(t) = -4.9t^2 + 44.1$ **b)** 44.1 m **c)** 60.75 m

9. **a)** -11 m/s
b) $h(t) = -5t^2 - 11t + 180$, as -11 is the initial velocity and 180 is the initial height when $t = 0$

10. **a)** \$4 **b)** \$50

11. **a)** A car cannot drive slower than 0 km/h, and the skid marks cannot be less than 0 m long.
b) $D(x) = 0.007x^2$
c) 25.2 m
d) e.g., type of car, tires, road conditions

12. e.g., $y = \frac{3}{3481}x^2 + 2$

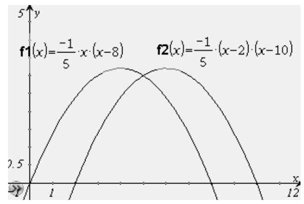
13. **a)** $h(x) = -\frac{36}{169}(x - 6.5)^2 + 9$; $\{x \mid 0 \le x \le 13, x \in \mathrm{R}\}$
b) 7.5 ft
c) about 7.1 ft
d) e.g., Drive through the centre of the road. Maximum height = 7 ft. Maximum width = 7 ft.

14. $y = 0.0009x^2 - 21.94$

15. $p = -\frac{3}{5}(d - 75)^2 + 1600$

16. **a)** \$700 **b)** 420
c) e.g., With fewer people in the audience, it may be less enjoyable.

17. **a)**

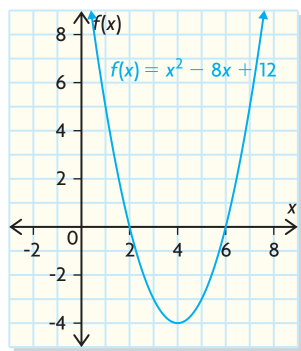


b) 3.2 m

18. **a)** $A = \frac{2}{3}x(600 - x)$ **c)** 300 m by 200 m
b) 60 000 m^2 **d)** 100 lots

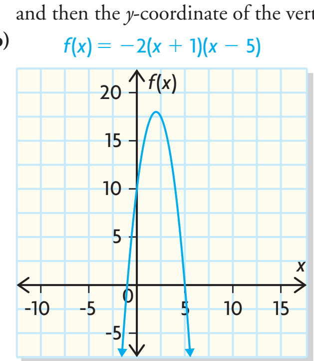
Chapter Self-Test, page 383

1. **a)**



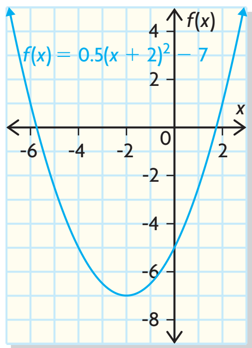
e.g., I used partial factoring to determine two points on the parabola with the same y-coordinate, then the axis of symmetry, and then the y-coordinate of the vertex.

b)



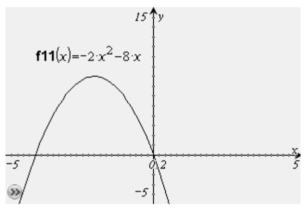
e.g., I plotted the x-intercepts and the y-intercept.

c)



e.g., I plotted the vertex and the x-intercepts.

d)



e.g., I factored the equation to determine the vertex and y-intercept.

2. **a)** x-intercepts: $-3, 5$; y-intercept: 15; vertex: $(1, 16)$
equation of the axis of symmetry: $x = 1$

b) x-intercepts: $1.5, -4$; y-intercept: -12; vertex: $(-1.25, -15.125)$
equation of the axis of symmetry: $x = -1.25$

3. **a)** 10 s **b)** 256 ft **c)** 400 ft

4. $f(x) = 3x^2 + 12x + 9$

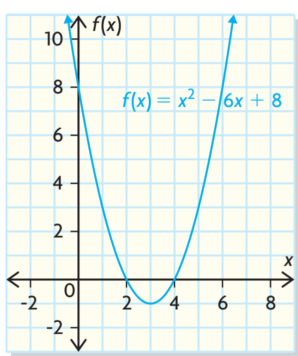
5. $y = \frac{1}{3}x^2 - 2x - 4$

6. $930

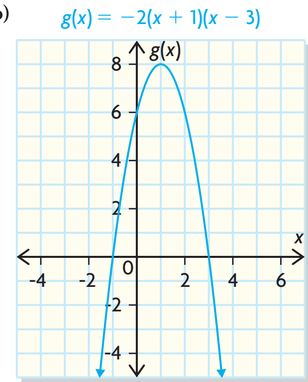
7. The top of the arch is 10 feet high. The door will be 5.6 feet tall, which won't give enough headroom.

Chapter Review, page 386

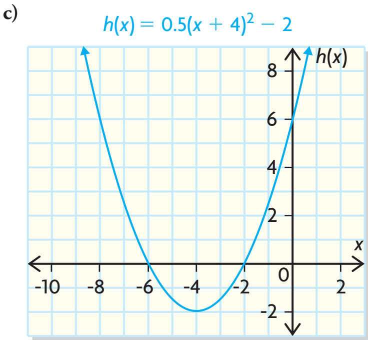
1. **a)**



b)



c)



2. e.g., The zeros are $x = 0$ and $x = 23$; the equation of the axis of symmetry is $x = 11.5$.

3. $(2, 7)$

4. **a)** 47 m

b) $\{(t, h(t)) \mid 0 \leq t \leq 6.07, t \in R, 0 \leq h(t) \leq 47, h(t) \in R\}$

5. **a)** $y = -\frac{3}{2}(x+1)^2 + 2$

b) $\{(x, y) \mid -1 \leq x \leq 0, x \in R, 0.5 \leq y \leq 2, y \in R\}$

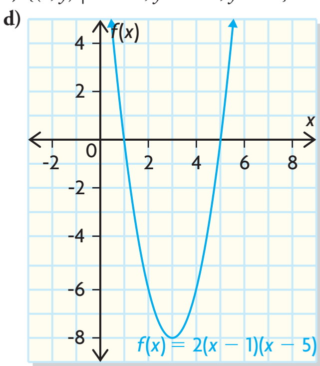
6. $(-6.25, -23.63)$

7. **a)** $f(x) = 2(x - 1)(x - 5)$

b) zeros: $x = 1, x = 5$
equation of the axis of symmetry: $x = 3$

c) $\{(x, y) \mid x \in R, y \geq -8, y \in R\}$

d)

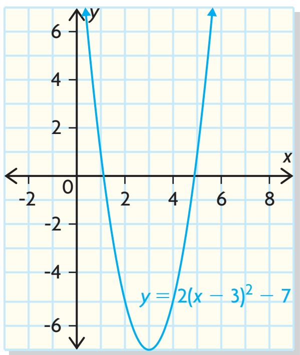


8. $x = -1.5, 4$

9. a) $(1, 2)$
   b) $(-2.5, 0.25)$

10. a) $y = -3(x + 1)^2 - 3$ b) $y = (x - 5)^2 + 1$

11. a) upward
    b) $x = 3, (3, -7)$
    c) $\{(x, y) \mid x \in \mathbb{R}, y \geq -7, y \in \mathbb{R}\}$
    d)



12. $y = -(x + 1)^2 + 3$

13. $y = -3(x + 4)(x + 2)$

14. $y = -\frac{1}{4}(x - 3)^2 - 5$

15. $y = -0.45x^2 + 45$

16. a) e.g., $-0.00425x^2 + 61$
    b) e.g., the distance between the arches

17. Yes

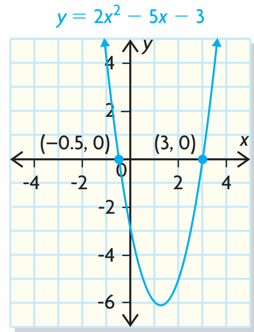
18. 20 m by 40 m, 800 m²

19. e.g., $y = -\frac{1}{360}(x - 65)(x + 65)$, $y = -\frac{1}{360}x^2 + \frac{13}{36}x$

Chapter 7

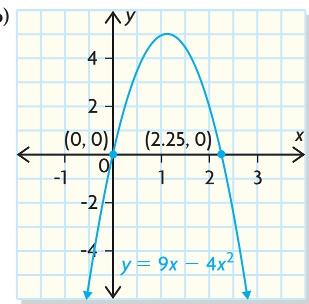
Lesson 7.1, page 402

1. a)



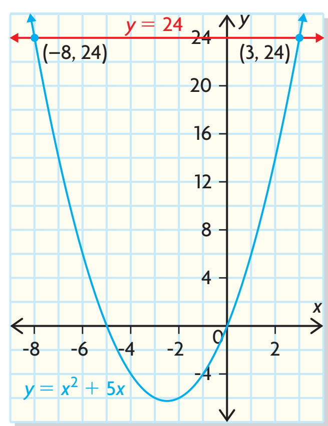
$x = -0.5, 3$

b)



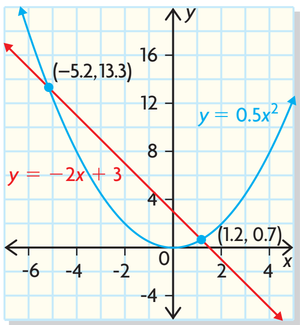
$x = 0, 2.25$

2. a)



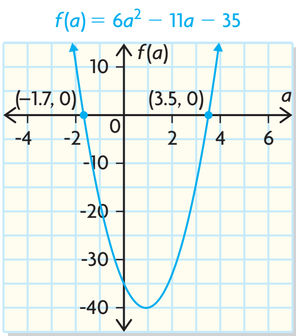
$x = -8, 3$

b)



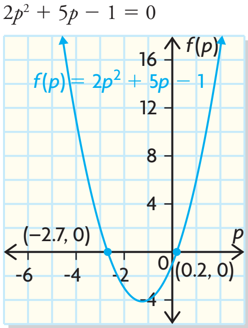
$x \doteq -5.162, 1.162$

3\. a) $6a^2 - 11a - 35 = 0$



$a \doteq -1.667, 3.5$

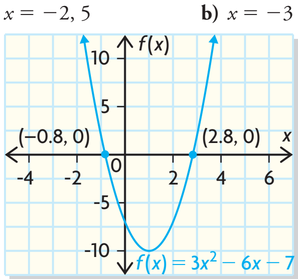
b) $2p^2 + 5p - 1 = 0$



$p \doteq -2.686, 0.186$

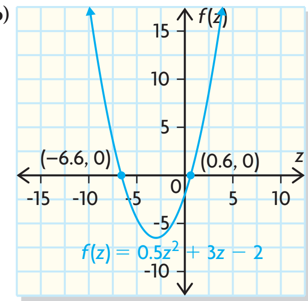
4\. a) $x = -2, 5$ b) $x = -3$

5\. a)



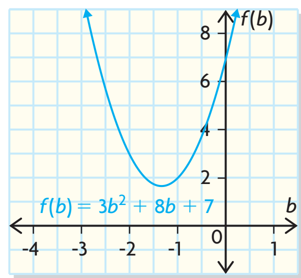
$x \doteq -0.826, 2.823$

b)



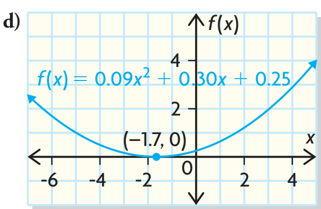
$z \doteq -6.606, 0.606$

c)



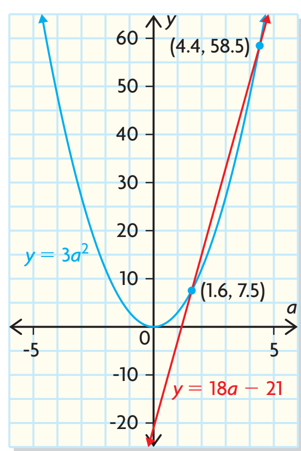
no real roots

d)



$x = -1.67$

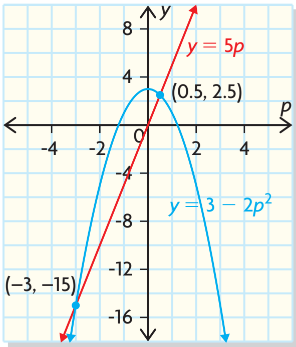
6\. a)



$a \doteq 1.586, 4.414$

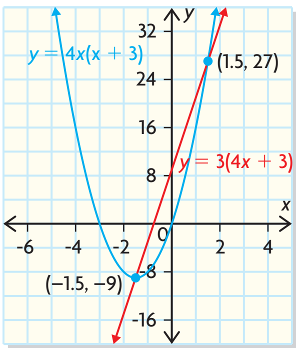
Answers

b)



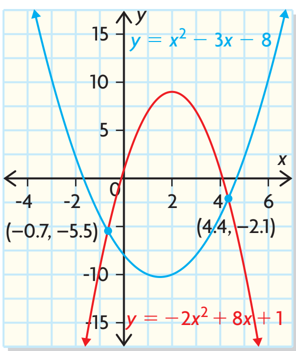
$p = -3, 0.5$

c)



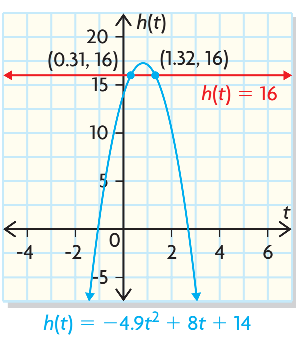
$x = 1.5, -1.5$

d)



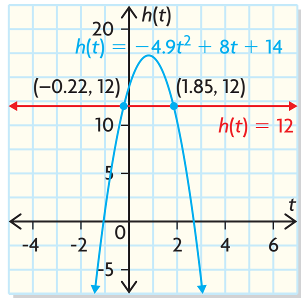
$x \doteq -0.689, 4.356$

7. a) $16 = -4.9t^2 + 8t + 14$



$t = 0.31$ s and $t = 1.32$ s

b) $12 = -4.9t^2 + 8t + 14$



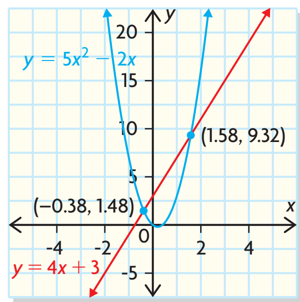
$t \doteq -0.22, 1.85$

$t \geq 0$, $t = 1.85$ s

c) No; the maximum height is less than 18.

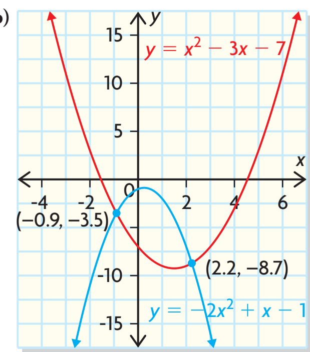
d) $t \doteq 2.69$ s

8. a)



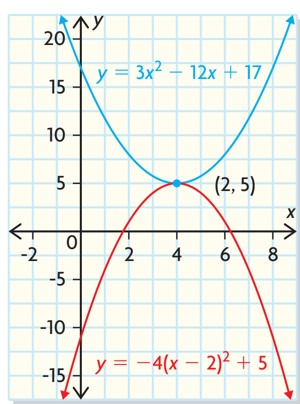
$x = -0.380, 1.580$

b)



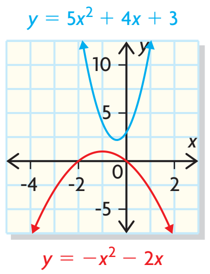
$x = -0.897, 2.230$

c)



$x = 2$

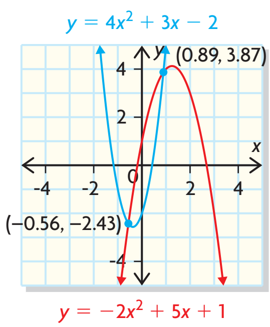
d)



no solution

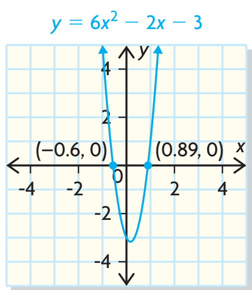
9. Yes, solving $120 = 0.0059s^2 + 0.187s$ indicates that the driver was travelling 127.65 km/h.

10. **a)**



(−0.560, −2.426), (0.893, 3.870)

b) $6x^2 - 2x - 3 = 0$



$x = -0.560, 0.893$

c) e.g., I prefer using the method in part b) because there is only one function to graph.

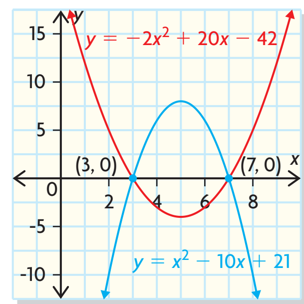
11. 9 m by 13 m

12. **a)** Kevin did not determine the values at the point of intersection, but determined the zeros for the LS function.
b) $x = 0.153, 2.181$

13. **a)** $x = -23.887, 29.807$
b) $x = -0.605, 7.631$

14. e.g., If the function crosses the x-axis at more than one place, there are two roots; if the function touches the x-axis at one place, there are two equal roots; if the function does not cross the x-axis, there are no real roots.

15.



e.g., $3x^2 - 30x + 63 = 0$, $3x^2 - 30x = -63$, $x^2 - 10x + 21 = 0$

Lesson 7.2, page 411

1. **a)** $x = 4, 7$ **b)** $y = -3, 10$ **c)** $x = -5, -0.5$ **d)** $t = -3, 1.25$

2. **a)** $x = 11, -11$ **b)** $r = \frac{10}{3}, -\frac{10}{3}$ **c)** $x = 0, 15$ **d)** $y = -16, 0$ **e)** $s = 6$ **f)** $p = -0.25$ **g)** $z = 0, 2.5$ **h)** $q = 0, \frac{9}{5}$

3. **a)** $x = -5, 14$ **b)** $x = -16, -3$ **c)** $a = -4, \frac{1}{3}$ **d)** $t = -\frac{4}{3}, \frac{5}{2}$

4. **a)** $x = -4, \frac{3}{2}$ **b)** $x = -3, \frac{3}{4}$ **c)** $d = -\frac{3}{7}$ **d)** $g = \frac{13}{9}, -\frac{13}{9}$

5. **a)** $x = -0.75, 1.8$
b) e.g., Geeta may have had the wrong signs between the terms within each factor.

6. **a)** $u = -7, 9$ **b)** $x = -4, -2$ **c)** $y = -6, 2$ **d)** $k = -5$

7. e.g., $x^2 + 17x + 60 = 0$

8. The price of the ticket should be either \$0.50 or \$3.50. (That is, $x = -5$ or $x = 15$.)

9. $x = \frac{1}{4}, \frac{8}{5}$

10. Going from the second line to the third line, 100 divided by 5 is 20, not 25. Also, in the final step, it is possible that the final result could be positive or negative. Therefore, the two solutions are $a = -\sqrt{20}$ or $a = \sqrt{20}$.

11. The first line was incorrectly factored:

$4r^2 - 9r = 0$
$r(4r - 9) = 0$
$r = 0$ or $4r - 9 = 0$
$4r = 9$
$r = \frac{9}{4}$
$r = 0$ or $r = \frac{9}{4}$

12. a) e.g., $y = 8x^2 + 2x - 3$
b) e.g., No, we had different functions.
c) e.g., $y = 16x^2 + 4x - 6$, $y = -24x^2 - 6x + 9$

13. a) She must sell either 600 or 1800 posters to break even.
b) She must sell either 800 or 1600 posters to earn a profit of \$5000.
c) She must sell 1200 posters to earn \$9000.
d) D: $n \geq 0$; R: $-27 \leq P \leq 9$
If Sanela sells 0 posters, she will incur a loss of \$27 000; her maximum profit is \$9000.

14. a) 7 s
b) D: $0 \leq t \leq 7$, where t is the time in seconds, since the rock hits the water at 7 s

15. a) e.g., $x^2 - 2x - 8 = 0$
b) e.g., $x^2 - 2x - 9 = 0$; I changed the "c" term.

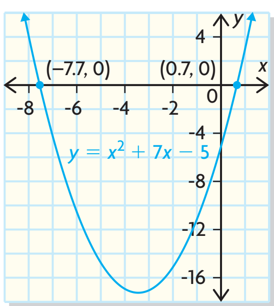
16. a) i) Write the equation in standard form.
ii) Factor fully.
iii) Set each factor with a variable equal to zero (since the product is zero, one factor must be equal to zero).
iv) Solve.
b) When the quadratic equation is factorable, solve by factoring; otherwise, solve by graphing.

17. a) One factor is $(x - 6)$ and the other factor is $(x + 6)$.
b) $x = -6$
c) $(x + 6)(x - 6) = 0$
d) $x^2 - 36 = 0$

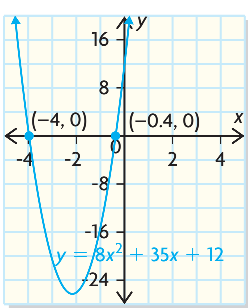
18. 10 cm, 24 cm, and 26 cm

Lesson 7.3, page 419

1. a) $x = \dfrac{-7 - \sqrt{69}}{2}, \dfrac{-7 + \sqrt{69}}{2}$

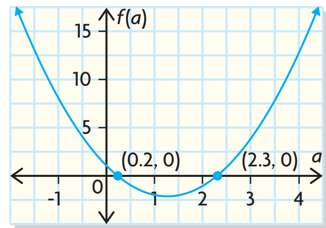


b) $x = -4, -0.375$

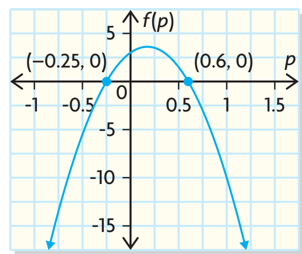


c) $a = \dfrac{5 - \sqrt{17}}{4}, \dfrac{5 + \sqrt{17}}{4}$

$f(a) = 2a^2 - 5a + 1$



d) $p = -0.25, 0.6$



$f(p) = -20p^2 + 7p + 3$

2. a) $x = -6, 1$
b) $x = -\dfrac{4}{9}, 0$
c) $x = 2.2, -2.2$
d) $x = -\dfrac{5}{4}, \dfrac{8}{3}$

3. e.g., I preferred factoring because it takes less time and there is less room for errors.

4. a) $x = \dfrac{-5 - \sqrt{133}}{6}, \dfrac{-5 + \sqrt{133}}{6}$
b) $x = \dfrac{7 - \sqrt{1102}}{39}, \dfrac{7 + \sqrt{1102}}{39}$
c) $x = \dfrac{3 - \sqrt{3}}{2}, \dfrac{3 + \sqrt{3}}{2}$
d) no solution

5. The roots are correct.

6. a) $x = \dfrac{3 - 2\sqrt{3}}{3}, \dfrac{3 + 2\sqrt{3}}{3}$
b) $x = -4 - \sqrt{13}, -4 + \sqrt{13}$
c) $x = \dfrac{-2 - \sqrt{6}}{4}, \dfrac{-2 + \sqrt{6}}{4}$
d) $x = \dfrac{2 - \sqrt{5}}{3}, \dfrac{2 + \sqrt{5}}{3}$

7. a) \$0.73, \$19.27
b) \$10

8. a) 5.5 s
b) e.g., about 10 s as 250 m is twice 125 m
c) 7.6 s
d) e.g., My prediction was not close.

9. a) It may be possible, but the factors would not be whole numbers.
b) $z = -0.75$
c) e.g., I used the formula because I find it most efficient.

10. **a)** 7.28 s
b) 1.77 s; The ball would be in flight 5.51 s longer on the Moon.

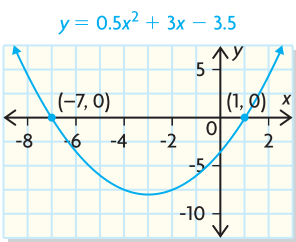
11. 0.25 m

12. e.g.,
- The quadratic formula can be used to solve any quadratic equation.
- You can use it to solve a factorable equation if you find it too difficult to factor.
- The radicand can be used to tell you about the solution.
  - If it is a perfect square, then the equation is factorable. Both roots are rational numbers.
  - If it is not a perfect square, then the roots can be given as a decimal approximation, or you can choose to leave the radical in the solution and give the exact values.
  - If it is negative, then there is no solution.

13. **a)** $-\frac{b}{a}$
b) $\frac{c}{a}$
c) $x = 0.5, 0.8$; sum $= 1.3$; product $= 0.4$
d) Yes, the answers match.
e) 1. d) sum: $\frac{7}{20}$; product: $-\frac{3}{20}$
2. a) sum: -5; product: -6
5. sum: -2; product: -15
7. sum: 20; product: 14
f) e.g., Determine the sum and product of your proposed solutions, then check to see if they match the results obtained from the formulas in parts a and b.

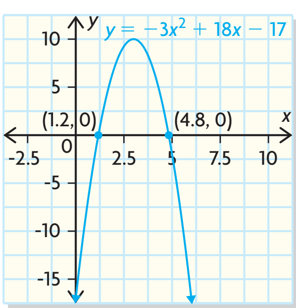
Mid-Chapter Review, page 424

1. **a)**



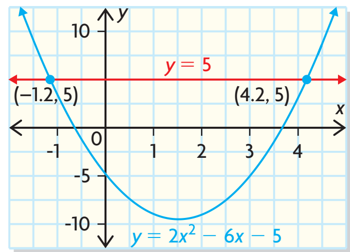
$x = -7, 1$

b)



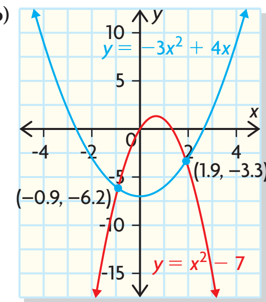
$x = \frac{9 + \sqrt{30}}{3}, \frac{9 - \sqrt{30}}{3}$

2. **a)**



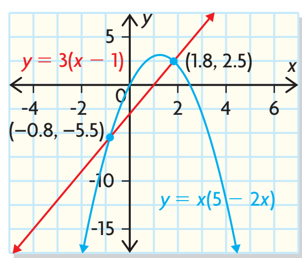
$x = \frac{3 - \sqrt{19}}{2}, \frac{3 + \sqrt{19}}{2}$

b)



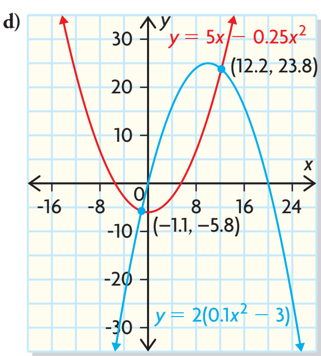
$x = \frac{1 - 2\sqrt{2}}{2}, \frac{1 + 2\sqrt{2}}{2}$

c)



$x = \frac{1 - \sqrt{7}}{2}, \frac{1 + \sqrt{7}}{2}$

d)



$x = \frac{50 - 2\sqrt{895}}{9}, \frac{50 + 2\sqrt{895}}{9}$

Answers

3. 14.06 s

4. a) $x = -4, 1$
   b) $z = -4.5, 5$

5. a) $x = -3, \frac{1}{2}$
   b) $a = -\frac{5}{6}$
   c) $c = \frac{3}{4}, \frac{5}{2}$
   d) $p = \frac{1}{4}$
   e) $t = -\frac{9}{2}, \frac{9}{2}$
   f) $x = -\frac{16}{3}, \frac{16}{3}$
   g) $w = 0, \frac{5}{3}$
   h) $x = 0, \frac{7}{3}$

6. e.g., $0 = 2x^2 + 11x - 6$

7. a) $k = \frac{-5 - \sqrt{37}}{6}, \frac{-5 + \sqrt{37}}{6}$
   b) $n = \frac{-15 - \sqrt{33}}{16}, \frac{-15 + \sqrt{33}}{16}$
   c) $x = \frac{4}{5}, 2$
   d) $y = -\frac{17}{2}, -\frac{11}{4}$

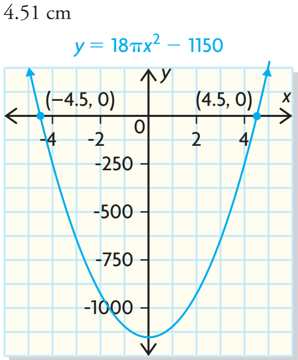
8. a) $p = -4, -\frac{3}{2}$
   b) $x = \frac{12 - \sqrt{344}}{10}, \frac{12 + \sqrt{344}}{10}$
   c) $a = \frac{-23 - \sqrt{193}}{24}, \frac{-23 + \sqrt{193}}{24}$

9. a) The price will have to increase \$5.54 or \$18.34.
   b) It is not possible as the maximum value according to the function is less than \$140 000.

Lesson 7.4, page 430

1. a) e.g., Graph the equations and find the intersection.
   b) 23.76 m
   c) e.g., Factor the equation to find the x-intercepts.

2. a) 4.51 cm
   b)



   c) e.g., I prefer the method in part a) because it takes less time.

3. $-8, 19$

4. 4.24 cm

5. about 1.57 s

6. 8:27 a.m.

7. a) $E(x) = -5x^2 + 75x + 5000$
   b) \$40
   c) \$32.50

8. -14 and -13, or 13 and 14

9. about 29 cm

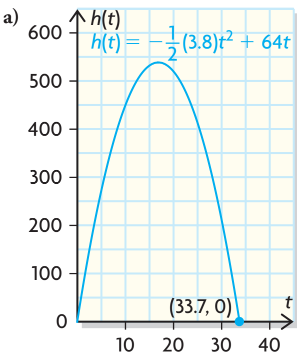
10. e.g., Underline key words, write what is given, write what you need to figure out, draw a picture, use a strategy previously used, and ask yourself if the answer is probable.

11. 6:30 pm

12. 10 cm

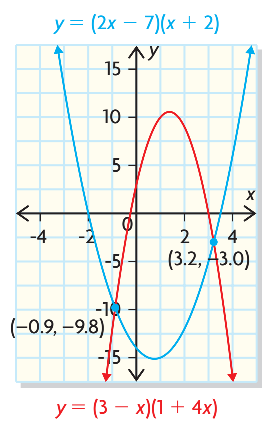
Chapter Self-Test, page 433

1. a)



   33.7 s
   b) 8.3 s, 25.4 s
   c) No, the maximum height reached is less than 550 m.

2.



   $x = \frac{7 - \sqrt{151}}{6}, \frac{7 + \sqrt{151}}{6}$

3. a) $y = \frac{25}{9}, \frac{-25}{9}$
   b) $z = 0, 2$
   c) $c = 4, -4$
   d) $h = 0, \frac{4}{5}$

4. a) $x = -8, -3$
   b) $a = -4, \frac{1}{8}$
   c) $c = -1, 6$
   d) $x = -\frac{2}{5}, -\frac{1}{4}$

5. a) $x = \frac{-5 - \sqrt{57}}{2}, \frac{-5 + \sqrt{57}}{2}$

b) $x = \frac{3 - 2\sqrt{3}}{2}, \frac{3 + 2\sqrt{3}}{2}$

c) $x = \frac{3}{5}$

d) no solution

6. The numbers are 8, 10, and 12.

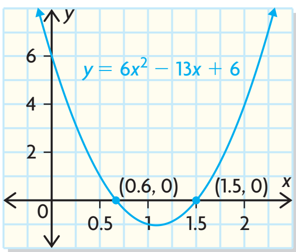
7. a) 56.2 m

b) about 4 m

8. about 10 cm by 15 cm

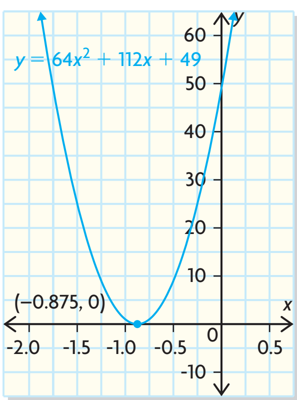
Chapter Review, page 436

1. a)



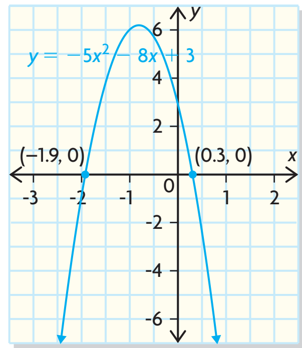
$x = \frac{2}{3}, \frac{3}{2}$

b)



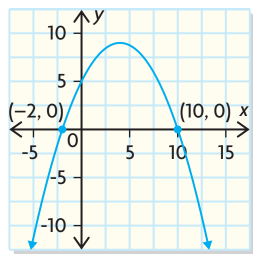
$x = -0.875$

c)



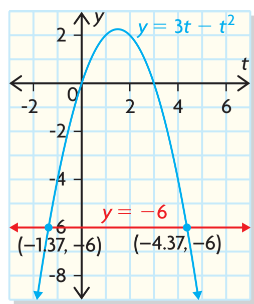
$x = \frac{-4 - \sqrt{31}}{5}, \frac{-4 + \sqrt{31}}{5}$

d) $y = -0.25x^2 + 2x + 5$



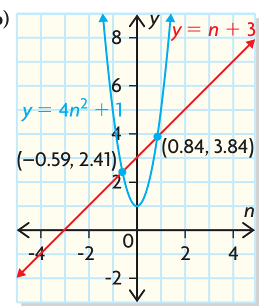
$x = -2, 10$

2. a)



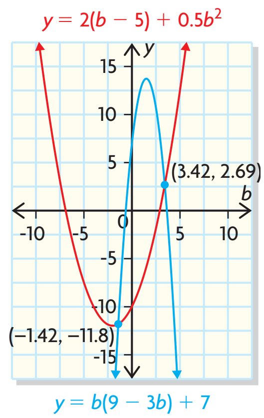
$t = -1.37, 4.37$

b)



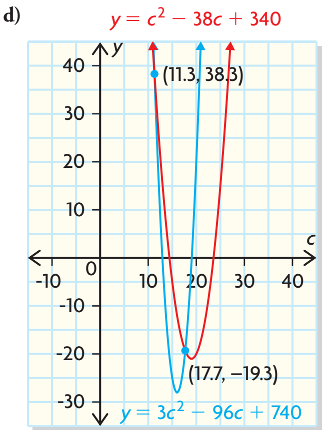
$n = -0.59, 0.84$

c)



$b = -1.42, 3.42$

d)



$c = 11.30, 17.70$

3. **a)** $s = -5, 12$
b) $x = -2.5, 0.8$
c) $a = -3, -2$
d) $x = -2, \frac{1}{3}$
e) $d = 3.25, -3.25$
f) $r = 0, \frac{8}{3}$
g) $x = 4.5, -4.5$
h) $m = -8, 0$

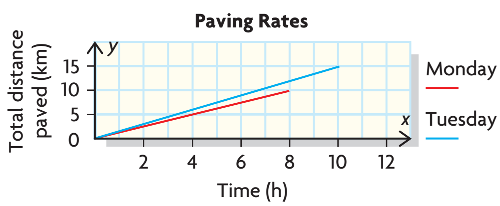
4. **a)** $x = \frac{11}{13}, \frac{16}{9}$
b) $x \doteq 0.73, -2.73$
c) $x \doteq 0.52, -1.38$
d) no solution

5. The numbers are 1, 3, 5 or 3, 5, 7.
6. The other side is 45 cm; the hypotenuse is 51 cm.
7. 1:59 p.m.
8. **a)** 500 m
b) 22.4 s
9. ± 16 and ± 28
10. \$6.25

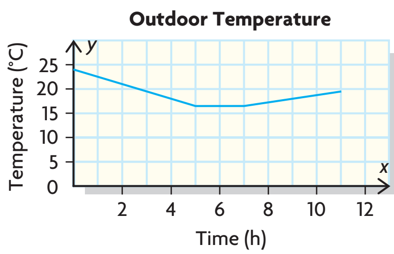
Chapter 8

Lesson 8.1, page 450

1. **a)** store A: \$8.50/kg; store B: \$7.35/kg; store B has the lower rate
b) station A: \$0.94/L; station B: \$0.98/L; station A has the lower rate
2. **a)** tank A: 70.6 L/h; tank B: 69.2 L/h; tank A has the greater rate
b) person A: 5.33 m/s; person B: 3.13 m/s; person A has the greater rate
3. **a)** 20 s to 28 s; 28 s to 32 s
b) 28 s; 32 s
c) distance does not change; speed is zero
4. **a)** bottles: \$0.001 75/mL; boxes: \$0.001 66/mL
b) Boxes have the lower unit cost.
5. 925 mL container: \$0.022/mL; 3.54 L container: \$0.015/mL; The larger container has the lower unit cost.
6. aerobics: 7 cal/min; hockey: 8 cal/min; She burns calories at a greater rate playing hockey.
7. **a)** 10 lb for \$17.40 is the same as \$3.83/kg; \$3.61 is the lower rate.
b) 6 mph is the same as 10 km/h; 2 km in 10 min is the same as 12 km/h; the first rate is lower.
c) 35.1 L for 450 km is the same as 7.8 L/100 km; this is the lower rate
d) 30 m/s is the same as 108 km/h; 100 km/h is the lower rate.
8. Farmer's Co-op: \$0.852/lb; pet store: \$0.623/lb; pet store has the lower rate
9. telephone company: \$24/year; Internet: \$28.95/year
10.



11.



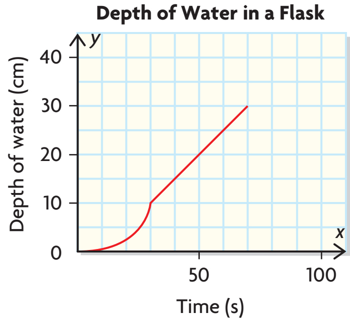
12. e.g., In the first 10 min, the shuttle was driven away from the airport to pick up and drop off passengers at three different hotels; the farthest hotel was about 9 km away. Then the shuttle was driven toward the airport for one more pick-up/drop-off about 4.5 km from the airport. It continued toward the airport and stopped at one more hotel, where David disembarked. The whole trip took about 22 min.
13. **a)** graduated cylinder **b)** flask **c)** beaker **d)** drinking glass

14. The rates for 1990–1995 and 1995–2000 are both 4.8 megatonnes/year.

15. The greatest speed difference is in the 700 m to 1100 m segment, by 0.113 m/s.

16. e.g.,
- **a)** An estimate is sufficient when you only need to know which rate is better, such as which car uses less fuel per kilometre. A precise answer is needed if you want to know how much fuel you will save for a particular trip.
- **b)** A graphing strategy is a good approach for comparing rates because you can visually compare the slopes. For example, a steeper slope for one lap of a car race on a graph of distance versus time means a faster speed. A numerical strategy is better if you want to know exactly how much faster one lap was compared to another.

17. **Depth of Water in a Flask**



18.
- **a)** about 14 300
- **b)** e.g., 27 079 MIPS; about 3693

Lesson 8.2, page 458

1.
- **a)** 9 L
- **b)** 3 min
- **c)** $12.75
- **d)** about 30 mL

2.
- **a)** Supersaver: $0.25/can; Gord: $0.28/can; Supersaver has the lower unit price.
- **b)** e.g., size of container, amount that must be bought

3. 56 turns

4. 18 games

5. 6% per year

6. e.g.,
- **a)** cost for meat in a grocery store
- **b)** amount of medicine per body mass
- **c)** cost for cold cuts at the deli counter
- **d)** change in temperature as altitude changes when climbing a mountain
- **e)** density of a substance
- **f)** cost of flooring at a hardware store

7. 4 min 16 s

8. 44 min

9. 20

10. 867 h

Strategy 1: She works 50 h every 3 weeks; therefore, she works approximately 16.667 h in 1 week (50 h/3 weeks). Since there are 52 weeks in a year, she works approximately 866.7 h in a year (16.667 h/week × 52 weeks/year)

Strategy 2:

$$\frac{52\text{ h}}{3\text{ weeks}} = \frac{x}{52\text{ weeks}}$$

Solve for x to get approximately 866.7 h.

11. **a)** 65.2 km/h **b)** 9.8 L/100 km **c)** $1.09/L

12. $704.50

13.
- **a)** $817.95
- **b)** no, for 8 weeks she would need 844.6 pounds
- **c)** e.g., What is the food's shelf-life? How much space will be needed to store the food? What are the shipping charges?

14. e.g.,
- **a)** about 356 000 ha
- **b)** about $17.1 million

15. store A: $0.416/L; store B: $0.441/L

Store A, because it is closer and the water is less expensive per litre.

16. 7:25 a.m.

17. −2.2 °C

18.
- **a)** Bren's Interior Design
- **b)** e.g., The distance to the store or whether a second coat will be needed.

19. 1268

20. 4.7 h

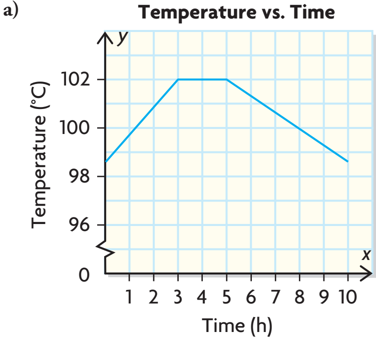
Mid-Chapter Review, page 465

1. Carol is faster, because Jed's keying rate is 58 words/min.

2. Stan paid less per litre, because Harry paid $0.985/L.

3. **a)** 4 Cal/min **b)** 30 L/day **c)** $8.40/kg **d)** 5 km in 20 min

4.
- **a)** **Temperature vs. Time**



- **b)** interval 0h to 3h

5.
- **a)** The interval about 28s to 35s; the slope is steepest over this interval.
- **b)** The interval about 35s to 60s; the slope is least steep over this interval.
- **c)** about 19 m/s; about 5 m/s
- **d)** 8.3 m/s

6.
- **a)** U.S. store, $114.47
- **b)** e.g., return/exchange/repair policies, service, custom duties, delivery time, shipping costs

7. 1000 miles

8. $102.20

9.
- **a)** 7.28 m/s, 7.21 m/s
- **b)** The average speed is slightly less for the race that is slightly longer.
- **c)** e.g., Longer races typically have lower average speeds.

Lesson 8.3, page 471

1. **a)** $\frac{3}{5} = 60\%$ **b)** $\frac{3}{2} = 150\%$

2. **a)** original smaller **b)** original larger **c)** original larger

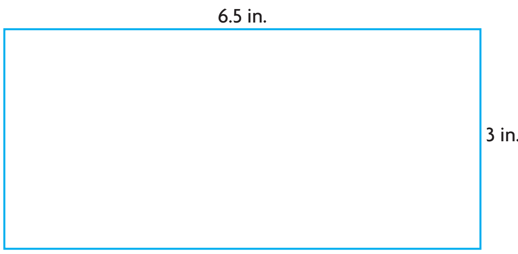
3. **a)** 5 in. : 6 ft or 5 in. : 72 in. **b)** $\frac{5}{72}$

4. $g = 4.0$ cm, $h = 1.0$ cm, $x = 6.0$ cm, $y = 7.5$ m

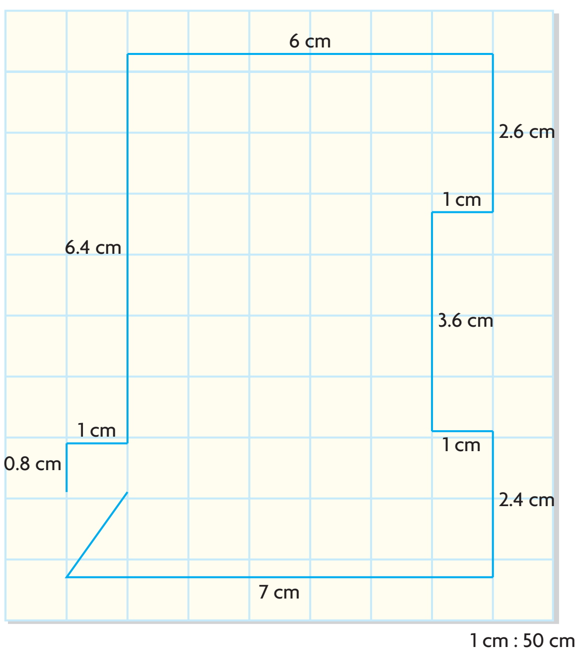
5. e.g.,
a) 1.2 **b)** 1.8 **c)** 0.9

6. **a)** 1, 3 m by 5 m; 2, 3 m by 3 m; 3, 3 m by 3 m
b) 4 m by 4 m
c) living room; 16 m^2

7. **a)** e.g., 1 in. : 100 ft
b) e.g.,

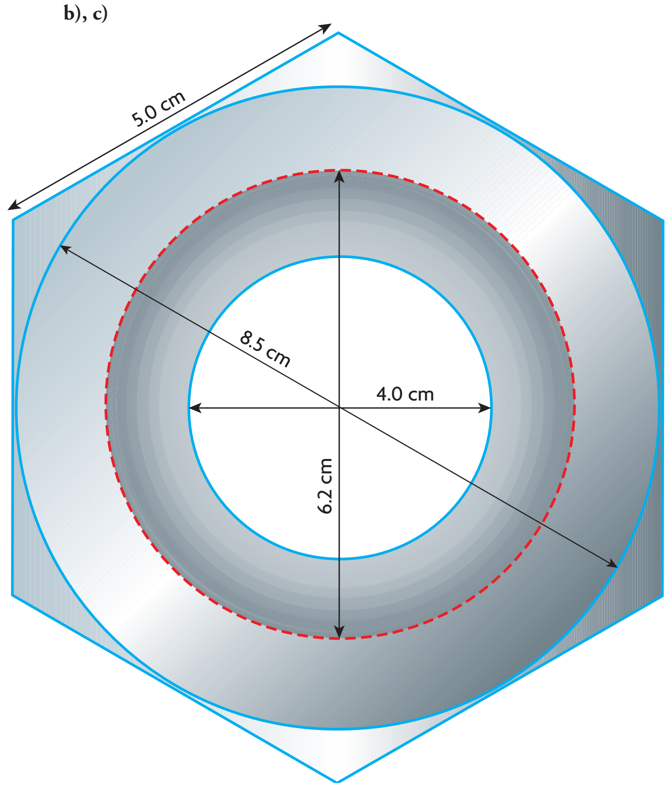


8.



9. The diagram should measure 13.5 cm by 9 cm.

10. e.g.,
a) diameters: 1.6 cm, 2.5 cm, 3.4 cm; hexagon side: 2.0 cm
b), c)



11. 0.25 mm

12. **a)** **i)** about 629 km
ii) about 557 km
b) Yellowknife and Fort Providence

13. **a)** 15 m **b)** 11.8 m^2

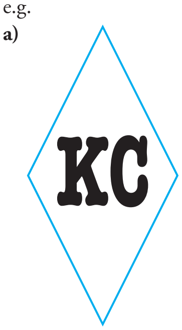
14. **a)** 3 **b)** $\frac{1}{20}$ **c)** 40 **d)** $\frac{1}{110}$

15. e.g., The diagram could be a rectangle measuring 18 cm by 14 cm.

16. **a)** 4 m^2 **b)** 2 m **c)** 5 mm : 2 m **d)** $\frac{1}{400}$

17. width = 36.6 in., height = 20.6 in.

18. e.g.
a)



b)

c)

19. e.g., The dimensions of the space you actually have for your scale diagram; how large you want the scale diagram to be in that space; and a comparison of the ratio of the dimensions of the available space to the ratio of the dimensions of the original.

20. **a)** 0.65 **b)** 7.8 in. by 5.2 in.

Lesson 8.4, page 479

1. **a)** 4:1 **b)** 12 cm^2, 192 cm^2 **c)** 16

2.

Length of Base (cm)	Height of Triangle (cm)	Scale Factor	Area (cm^2)	$\frac{\text{Area of scaled triangle}}{\text{Area of original triangle}}$
3.0	4.0	1	6.0	1
9.0	12.0	3	54.0	9
1.5	2.0	0.5	1.5	0.25
30.0	40.0	10	600.0	100
0.75	1.0	25%	0.375	0.0625

3. 1050 cm^2

4. **a)** 44 units^2 **b)** 52 units^2 **c)** 50 units^2

5. **a)** 2.5 units^2 **b)** 1.3 units^2

6. **a)** 6 in. by 9 in.
b) 225%
c) e.g., Enlarge each side by 150%, then multiply the new side lengths, or calculate the area of the smaller photo, then multiply by 2.25.

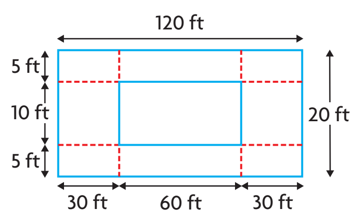
7. Enlarge each side length using a scale factor of 2.

8. **a)** $\frac{2}{3}$ **b)** 64 cm^2

9. garage: 600 m^2, office: 100 m^2

10. **a)** \$65 000 **b)** \$280 000

11.



12. 8 cm^2 and 32 cm^2

13. **a)** 1.5 **b)** 2

14. **a)** 4
b) The perimeter of the large triangle is 4 times the perimeter of the small triangle; the area of the large triangle is 4^2 times the area of the small triangle.

15. **a)** $0.152:7600 = 1:50\,000$
b) 49 ha
c) \$18 300

16. **a), b)**, e.g., If kitchen is about 10 ft by 20 ft and scale diagrams are drawn on 8.5 in. by 11 in. paper, scale factor could be $\frac{1}{48}$.
c) e.g., Estimate or measure the open floor space areas in each diagram and compare.

17. e.g., The area is divided by 4 in process A.

18. 81%

19. about 46¢ more

Lesson 8.5, page 489

1. **a)** similar
b) similar
c) similar
d) not similar

2. **a)** Yes, all spheres are similar.
b) **i)** $\frac{25}{22}$ **ii)** $\frac{22}{25}$

3. length: 52 m; beam: 8.5 m; height 43 m

4. **a)** Yes, all dimensions are proportional.
b) S: 16 cm; L: 32 cm

5. length: 8.6 m; height: 3.8 m

6. 1.41 m by 1.68 m by 3.71 m

7. **a)** 2 **b)** length: 180 cm; height: 150 cm

8. **a)** 1:3 **b)** 10 in.

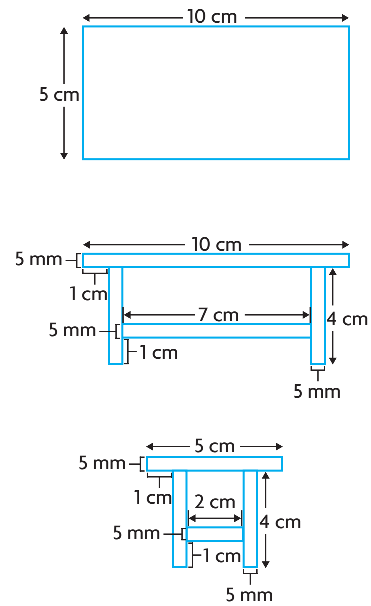
9. 16 in. by 2 in.

10. **a)** about 3 in. by 5 in. by 2 in.
b) $\frac{87}{160}$
c) $3\frac{1}{4}$ in. long, $4\frac{5}{8}$ in. high, $2\frac{1}{8}$ in. wide

11. 2

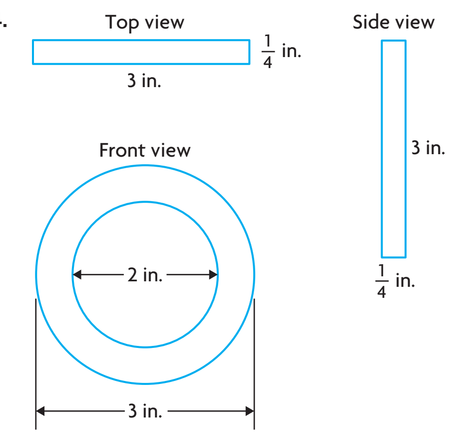
12. e.g.,
a) 6 m tall, 5 m wide
b) Measure the metre stick in the photo to determine the scale factor. Then multiply the building measurements by the scale factor to determine the building dimensions in metres.

13.



Answers

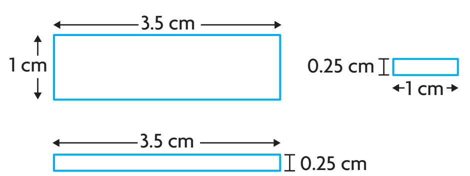
14.



15. e.g., Using a scale factor of $\frac{1}{20}$, the views would have the following dimensions:

Top view rectangle: 6.7 cm by 3.3 cm
Side view rectangle: 3.3 cm by 4.4 cm
Front view rectangle: 6.7 cm by 4.4 cm

16. e.g., for an eraser measuring 7.0 cm by 2.0 cm by 0.5 cm, using a scale factor of $\frac{1}{2}$:



17. **a)** no; The area of the base increases by the square of the scale factor.
b) no; The volume increases by the cube of the scale factor.
18. e.g., Both involve multiplying each dimension by a scale factor; shapes have two dimensions while objects have three dimensions.
19. **a)** 2.25
b) \$0.02
20. 25 cm^2

Lesson 8.6, page 500

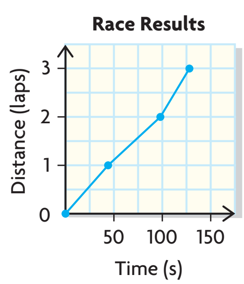
1. **a) i)** 4 **ii)** 8
b) i) $\frac{9}{4}$ **ii)** $\frac{27}{16}$
c) i) 16 **ii)** 64
d) i) $\frac{25}{9}$ **ii)** $\frac{125}{27}$
2. **a)** 50 **b)** 2500 **c)** 125 000
3. 480 cm, 7650 cm^2
4. 864 m^3
5. **a)** 4500 cm^2
b) 9; The thickness of the paper will not change.
6. 3974 cm^3
7. **a)** 3.375 **b)** 2.25 **c)** 1.5
8. 9 and 27
9. 6600 cm^3
10. **a)** 1750 **b)** 25
11. **a)** 2.7 cm **c)** 13.5
b) 3.7 **d)** 49.5
12. 2.7
13. 172%
14. **a)** 1.5 **c)** 3.375
b) 2.25 **d)** 987.81 cm^3, 3333.88 cm^3
15. **a)** No, it will take about four times as much $(k = 2; k^2 = 4)$.
b) No, it is $\frac{1}{8}$ the volume of the large shoebox $\left(k = \frac{1}{2}; k^3 = \frac{1}{8}\right)$.
16. **a)** Surface area of scaled cylinder $= k^2(2\pi r^2 + 2\pi rh)$
Volume of scaled cylinder $= k^3(\pi r^2 h)$
b) Surface area of scaled cone $= k^2(\pi r^2 + \pi rs)$
Volume of scaled cone $= k^3\left(\frac{1}{3}\pi r^2 h\right)$
17. e.g., Consider the relationship between the volumes. The scale factor is 2, so the larger prism has a volume that is 8 times the volume of the smaller prism. Eight of the smaller prisms will fit inside the larger prism.
18. 9
19. **a)** 37 914 864 km^2 **b)** 21 952 700 000 km^3
20. \$20.16, assuming the heights are the same and that frosting costs the same as the interior of the cake.

Chapter Self-Test, page 504

1. **a)** increasing: 1993–1995, 1996–2000, 2001–2004, 2005–2008; decreasing: 1995–1996, 2000–2001, 2008–Aug. 2009
b) 2004–2005
c) 1998–1999; 2008–Aug. 2009
d) e.g., general economic conditions
2. 75 L
3. 1 m by 1.5 m
4. **a)** 2.4 cm, 6.8 cm **c)** 41.7 cm^2
b) 7.2 cm **d)** 54.7 cm^3
5. 11.5 ft
6. **a)** no
b) The largest pizza is the best buy.

Chapter Review, page 507

1.



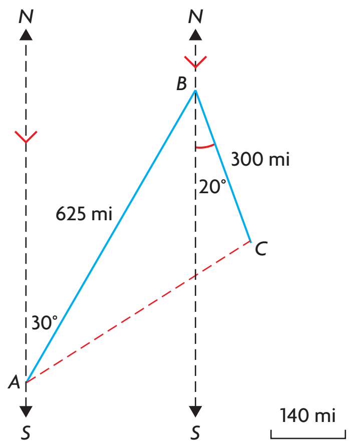
2. **a)** The second rate (\$2.26/kg) is lower.
b) The second rate (29 km/h) is lower.
c) The first rate is lower (the second is 6.8 L/100 km).
d) The first rate (36 km/h) is lower.
3. Yes, her projected time is under 2 h 39 min.
4. **a)** about 30 sq yards
b) locally (she will save about \$10)
5. 1 : 60 for the width and 3 : 200 for the height

6. e.g.,

a) $\frac{1}{2}$

b) for a book cover, a rectangle 10.5 cm by 13.2 cm

7. **a)**



b) Use a ruler to measure the distance from C to A on the scale drawing in part (a); then use the scale to calculate the actual distance.

8. **a)** 96%

b) 18%

c) e.g., Many marketers stretch the truth to make themselves look as good as possible, and if the pizzeria owners are like this, then they probably mean (b).

9. **a)** about 309 m^2 **b)** 2.84

10. **a)** 5.5 in. by 7.7 in. **b)** 21%

11. 2.5 cm

12. **a)** 1 : 6 **b)** 9 m

13. 2 ft 2in., 1 ft 7 in., 5.4 in.

14. 14 580 cm^3

15. 403 cm^2

16. 40 mm by 76 mm by 8 mm

Cumulative Review, Chapters 6–8, page 512

1. **a)** **i)** $f(x) = x(x - 8)$

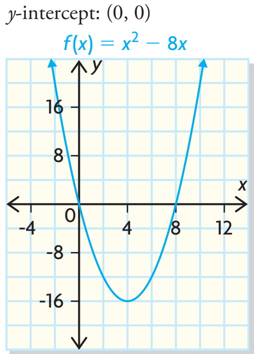
x-intercepts: (0, 0), (8, 0)

axis of symmetry: $x = 4$

vertex: (4, −16)

y-intercept: (0, 0)

ii)



iii) domain: all real numbers

range: $y \geq -16$

b) **i)** $y = (x + 5)(x - 3)$

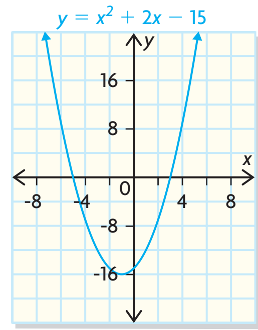
x-intercepts: (−5, 0), (3, 0)

axis of symmetry: $x = -1$

vertex: (−1, −16)

y-intercept: (0, −15)

ii)



iii) domain: all real numbers

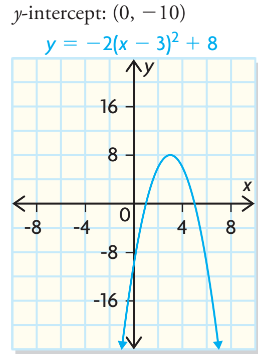
range: $y \geq -16$

2. **a)** **i)** axis of symmetry: $x = 3$

vertex: (3, 8)

y-intercept: (0, −10)

ii)



iii) domain: all real numbers

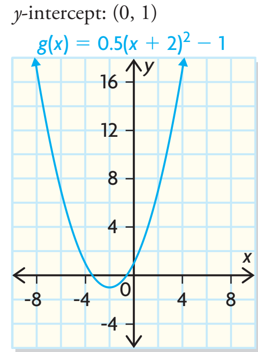
range: $y \leq 8$

b) **i)** axis of symmetry: $x = -2$

vertex: (−2, −1)

y-intercept: (0, 1)

ii)



iii) domain: all real numbers

range: $y \geq -1$

3. $y = -\frac{1}{4}(x + 4)(x - 8)$; $y = -\frac{1}{4}x^2 + x + 8$

Answers

4. **a)** up, because the coefficient of x^2 is positive
b) $(-3, -5)$
c) a minimum value, because it opens up

5. \$13

6. **a)** $-3, 3$ **b)** $-\frac{1}{2}, 3$

7. **a)** $-\frac{1}{2}, 5$ **d)** $3 \pm \sqrt{19}$
b) $-4, 8$ **e)** $1, 5$
c) $-\frac{2}{3}, 4$ **f)** $\frac{61 \pm \sqrt{3061}}{30}$

8. **a)** 4375 m **b)** 24.5 s

9. \$3.25

10. $x \geq 1; x = 65$
$y \geq -\frac{1}{5}$; no solution

11. 1 m

12. 60 min

13. **a)** 1500 m by 2500 m **b)** 375 ha

14. 65 m by 108 m by 215 m